The Pharma Innovation Journal 2023; 12(10): 2125-2129

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 2125-2129

www.thepharmajournal.com
Received: 11-07-2023
Accepted: 14-08-2023

Digamber
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

SS Jakhar
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Axay Bhuker
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Rahul Kumar
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Sultan Singh
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Gagandeep Singh
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Digamber
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Impact of Sowing Dates on Physiological and Biochemical Attributes of Cowpea (*Vigna unguiculata* (L.) WALP.)

Digamber, SS Jakhar, Axay Bhuker, Rahul Kumar, Sultan Singh and Gagandeep Singh

Abstract
The present investigation was conducted during the years 2019 and 2021 to study the effect of date of sowing on physiological and biochemical attributes of Cowpea. The cowpea variety CS88 was sown on three different dates, *viz*., March 30 (S_1), May 30 (S_2), and June 30 (S_3), under the recommended package and practices in a plot size of 12 m^2 (4.0 m x 3.0 m) with a row-to-row spacing of 30 cm for each treatment in three replications by using a split-split plot design. The result of the two-year experiment showed that there was a significant variation in the physiological parameters like test weight, standard germination speed of germination, seedling length, seedling dry weight, seedling vigour index, electrical conductivity, and Enzyme activities like Catalase (CAT), Peroxidase (POX), Dehydrogenase activity (DHA), and superoxide dismutase (SOD) were also significantly affected by different dates of sowing. The yield of different sowings varied significantly. The maximum germination percentage (88.79% and 87.73% in year 2019 and 2021 respectively) and maximum biochemical activity was recorded in seed obtained from the seeds of second sowing (May 30). On the basis of present investigation it is concluded that early sowing and a delay in sowing time both reduce the seed quality attributes of cowpea.

Keywords: Biochemical, Cowpea, Seed quality, Sowing date

Introduction

Cowpea {*Vigna unguiculata* (L.) Walp.} Is an annual legume that belongs to the family Leguminoceae (Cobbley and Steele, 1976) [5]. The wild *unguiculata* is common in tropical Africa, indicating that it was domesticated here before spreading to other areas of the world (Purseglove, 1976) [33]. The cowpea crop is primarily grown in savanna areas of tropical Africa, and the top producers of cowpea are Nigeria, Benin, Burkina Faso, and Niger. In terms of climatic adaption, cowpea is similar to maize, with the exception that it needs more heat and is therefore more susceptible to frost.

Cowpea is also termed as poor man's protein. Most likely it is Central Africa native crop. In terms of its nutritional aspects' cowpea grain has 23.4 per cent protein, 1.8 per cent fat and 60.3 per cent carbohydrate on dry weight basis. Besides it is a good source of calcium and iron. The plant shoot and leaves are very high in calcium, phosphorus, and Vitamin B content (Maynard, 2008) [24]. In general, cowpea is produced for fodder needs, green pods and grain purpose. It can also be used as a cover crop, mixed crop, catch crop, or green manuring crop in a number of cropping systems. Green pods of cowpea are used as a vegetable. Under well suited conditions, it has the able capacity to fix the atmospheric nitrogen in soil @ 56 kg ha^{-1} amalgamated with symbiotic bacteria (Yadav, 2003) [41].

The planting date is also among the most important factors that influence growth and yield. Crop germination, growth, yield, and quality depend on it. The planting date, as a climatic element, affects the vegetative and reproductive phases, as well as their ratio and hence the final output of legumes (Lopez *et al.*, 2008) [21]. The timing of planting is also crucial for planning and arranging a farmer's work schedule. The best strategy to increase the yield and quality of beans is to plant them at the appropriate time, taking into account the local environmental conditions. The ideal sowing date can be determined using both climate indicators like temperature, rainfall, day length, and wind as well as non-climate factors including pests, diseases, weeds, birds, and production expenses (Mazaheri and Majnoon, 2005) [25]. India produced 13.1 Mt of pulses from 22.4 Mha with an average productivity of 585 kg ha^{-1} in 2005-06 (Anonymous, 2007) [3].

India is the world's top producer and consumer of pulses. Pulses are produced in India in 25.23 million tonnes, with a predicted need of 35 Mt by 2030 (Farmer Portal, 2018) [10].
In our country, cowpea productivity is really low. Therefore, adequate agronomic measures must be taken to increase cowpea yield. Furthermore, an appropriate planting date extends the vegetative stage, allowing more assimilates to be transported to sinks, whereas a late planting date causes early flowering, resulting in a reduction in dry matter, a fall in the number of produced pods, and ultimately yield loss (Mozumber *et al.*, 2003) [28].
In our country, cowpea productivity is really low. Therefore, adequate agronomic measures must be taken to increase cowpea yield.

Materials and Methods
Freshly harvested seeds of variety CS-88 were procured from Forage Section, Department of genetics and plant breeding and study was conducted on farm research area and laboratory of department of Seed Science & Technology CCS Haryana Agricultural University, Hisar. The experiment was carried out using split-split plot design with three Replications. Three sowing dates *viz*. 30 March (S_1), 30 May (S_2) and 30 June (S_3) were taken. Plant height and number of leaves of three plants were recorded randomly, and these were averaged to calculate the mean height and number of leaves at different growth stages. The pod clusters, number of pods per clusters, number of pods per plant, pod weight per plant in three randomly selected plants were counted after full maturity of crop in each plot. Then it was averaged to calculate the mean value. The length and number of seeds per pod of five randomly selected pods after picking was averaged from each plot to get the mean value. Randomly 1000 seeds replicated thrice were counted from each treatment in each replication to calculate the test weight. For calculating standard germination one hundred seeds replicated thrice in each treatment in each replication were placed in between papers method (B.P.) and kept at 20±1 °C in seed germinator. The seedlings were evaluated on the day of final count (10th day) and normal seedlings were considered for per cent germination according to the rules of International Seed Testing Association (ISTA) 2011 [16]. Speed of germination was calculated according to the formula given by Maguire, 1962 [22]. The seedling vigour indices were calculated according to the method suggested by Abdul Baki and Anderson (1973) [1]. The electrical conductivity of seed leachates was measured by electrical conductivity meter (ISTA, 2015) [17]. The enzyme extract was prepared as described earlier for SOD and the CAT activity was measured by slightly modified method of Sinha (1972) [39]. The enzyme extract was prepared as described earlier for SOD and CAT was assayed for POX activity estimation by determining the rate of guaiacol oxidation in the presence of H_2O_2 at 470 nm (Rao *et al.*, 1998) [35]. Dehydrogenase activity (DHA) test was performed as per method given by Kittock and Law (1968) [20]. For the purpose of kinetic and regulatory properties, the enzyme activity is expressed in terms of units g^{-1} fresh weight and was calculated by the commonly used formula of Giannopolitis and Ries (1977) [13]. The statistical analysis will be done by using OPSTAT analytical software for split-split plot Design for field parameters and Completely Randomized Design (CRD) for laboratory parameters (Panse and Sukhatme, 1985) [30].

Results and Discussion
Physiological parameters
The test weight showed significant difference during both years *i.e.* 2019 and 2021 of experiment due to different dates of sowing (Table 1). Higher test weight was recorded in seeds of second sowing in both years (114.69g and 106.9g resp.) and seeds of third sowing showed minimum test weight among all the sowing dates (93.13g and 92.22g resp.) however results showed that first sowing gave better results as compared to other sowing dates the results are in conformity with Bensen and Temple (2008) [4].
Significant results were realized for standard germination per cent among different sowing dates (Table 1). The highest germination percentage was recorded in seed obtained from the seeds of second sowing 88.79% and 87.73% in year 2019 and 2021 resp. due to better environment condition during various stages of growth of plant. The lowest germination was observed in third sowing 85.03% and 84.19% in year 2019 and 2021 resp. the finding are congruent with what was previously reported by Sumalatha *et al.*, (2019) [40]. Results on speed of germination showed that there was a significant differences among the different sowing dates (Table 1). Maximum speed of germination was recorded in second sowing (0.70) followed by first sowing (0.62). The minimum speed of germination (0.47) was found in third sowing in year 2019. In year 2022 the maximum speed of germination (0.69) was found in second sowing and minimum speed of germination (0.46) was found in third sowing. Our data is in line with previous research conducted Bensen and Temple (2008) [4].
The seedling length (cm) of cowpea under different sowing dates had significance difference as presented in table 1. During both the years of experiment, seedling length was significantly affected by different sowing times. Maximum seedling length was recorded in second sowing (37.71 cm) followed by first sowing (33.08 cm). The minimum seedling length (27.58 cm) was found in third sowing in year 2019. In year 2021, the maximum seedling length (37.27 cm) was found in second sowing and minimum seedling length (27.31 cm) was found in third sowing.
Result on seedling dry weight (mg) of cowpea showed there was a significant difference in both the years (2019 and 2021) among the different dates of sowing (Table 1). During both the years of experiment, seedling length was significantly affected by different sowing times. Maximum seedling length was recorded in second sowing (295.75 mg) followed by first sowing (283.63 mg). The minimum seedling dry weight (278.75 mg) was found in third sowing in year 2019. In year 2021, the maximum seedling dry weight (289.75 mg) was found in second sowing and minimum seedling dry weight (273.94 mg) was found in third sowing. The results are in accord with earlier studies conducted by Kasul *et al.*, (2003) [18] and Khatun *et al.*, (2009) [19].
The vigour index – I of cowpea differs significantly due to different dates of sowing in both the years 2019 and 2021 (Table 2). Maximum vigour index-I was recorded in second sowing (3350) followed by first sowing (2912). The minimum vigour index-I (2350) was found in third sowing in year 2019. In year 2021, the maximum vigour index-I (3272) was found in second sowing and minimum vigour index-I (2302) was found in third sowing. These findings are supported by Dornbos (1995) [18] and Rahman *et al*., (2006) [34].
Seed from second sowing of cowpea in both the years of

experiment 2019 and 2021 showed significantly highest vigour index II 26277 and 25437 resp. followed by the first date of sowing 24948 and 23738 resp. the lowest vigour index II was showed in third date of sowing 23738 and 23907.

The data pertaining to vigour index-II of cowpea under different sowing dates is presented in table 2. During both the years of experiment, vigour index-II was significantly affected by different sowing times. Maximum vigour index-II was recorded in second sowing (26277) followed by first sowing (24948). The minimum vigour index-II (23738) was found in third sowing in year 2019. In year 2021, the maximum vigour index-II (25437) was found in second sowing and minimum vigour index-II (23907) was found in third sowing.

Results on electrical conductivity showed there was a significant difference among the seeds harvested from the different dates of sowing of cowpea (Table 2) Minimum electrical conductivity was recorded in second sowing (24.36 µS $cm^{-1}g^{-1}$) followed by first sowing (28.47 µS $cm^{-1}g^{-1}$). The maximum electrical conductivity (46.47 µS $cm^{-1}g^{-1}$) was found in third sowing in year 2019. In year2021 the minimum electrical conductivity (24.71 µS $cm^{-1}g^{-1}$) was found in second sowing and maximum electrical conductivity (46.90 µS $cm^{-1}g^{-1}$) was found in third sowing.

Biochemical parameters

The data pertaining to catalase activity of cowpea under different sowing dates is presented in table 3. During both the years of experiment, catalase activity was significantly affected by different sowing times. Maximum catalase activity was recorded in second sowing (44.87) followed by first sowing (41.43). The minimum catalase activity (32.95) was found in third sowing in year 2019. In year 2021, the maximum catalase activity (44.36) was found in second sowing and minimum catalase activity (32.62) was found in third sowing.

The data pertaining to peroxidase activity of cowpea under different sowing dates is presented in Table 3. During both the years of experiment, peroxidase activity was significantly affected by different sowing times. Maximum peroxidase activity was recorded in second sowing (0.347) followed by first sowing (0.317). The minimum peroxidase activity (0.268) was found in third sowing in year 2019. In year 2021, the maximum peroxidase activity (0.297) was found in second sowing and minimum peroxidase activity (0.238) was found in third sowing.

There was significant reduction in dehydrogenase activity from of cowpea under different sowing dates. During both the years of experiment, dehydrogenase activity was significantly affected by different sowing times. Maximum dehydrogenase activity was recorded in second sowing (2.55) followed by first sowing (2.32). The minimum dehydrogenase activity (1.96) was found in third sowing in year 2019. In year 2021, the maximum dehydrogenase activity (2.52) was found in second sowing and minimum dehydrogenase activity (1.94) was found in third sowing (Table 3).

Different Dates of sowing on cowpea during both the years 2019 and 2021 exhibited consistent and significant difference on superoxide on superoxide dismutase activity (table 3). The minimum superoxide dismutase activity (50.62) was found in third sowing in year 2019. In year 2021, the maximum superoxide dismutase activity (59.36) was found in second sowing and minimum superoxide dismutase activity (47.62) was observed in third sowing.

Field parameters

The data pertaining to field emergence index of cowpea under different sowing dates is presented in table 4. During both the years *i.e.* 2019 and 2021 of experiment, field emergence index was significantly affected by different sowing times. Maximum field emergence index was recorded in second sowing (23.95) followed by first sowing (20.35). The minimum field emergence index (17.11) was found in third sowing in year 2019. In year 2021, the maximum field emergence index (23.67) was found in second sowing and minimum field emergence index (16.94) was observed in third sowing. These findings are in accordance with the earlier studies conducted by Mazed *et al.*, (2015) [26].

The data pertaining to seedling establishment of cowpea under different sowing dates is presented in table 4. During both the years *i.e.* 2019 and 2021 of experiment, seedling establishment was significantly affected by different sowing times. Maximum seedling establishment was recorded in second sowing (84.79%) followed by first sowing (82.87%). The minimum seedling establishment (79.03%) was found in third sowing in year 2019. In year 2021, the maximum seedling establishment (82.73%) was found in second sowing and minimum seedling establishment (77.19%) was found in third sowing. So, second sowing is best for both the years.

Table 1: Effect of sowing date on seed quality parameters (Test weight, Germination, Speed of germination, Seedling length, Seedling dry weight)

Year (2019)					
Sowing date ↓	**Test weight (g)**	**Germination percentage**	**Speed of germination**	**Seedling length (cm)**	**Seedling dry weight (mg)**
S_1(30 March)	106.91	87.87	0.62	33.08	283.63
S_2(30 May)	114.69	88.79	0.70	37.71	295.75
S_3(30 June)	93.13	85.03	0.47	27.58	278.75
CD@5%	0.20	0.05	0.002	0.03	4.14
Year (2021)					
S_1(30 March)	104.02	85.50	0.61	32.19	279.50
S_2(30 May)	113.33	87.73	0.69	37.27	289.75
S_3(30 June)	92.22	84.19	0.46	27.31	273.94
CD@5%	0.14	1.80	0.003	0.07	0.14

Table 2: Effect of sowing date on Seed quality parameters (Vigour index and electrical conductivity)

Sowing date ↓	Vigour index-I	Vigour index-II	Electrical conductivity (μS $cm^{-1}g^{-1}$)
Year (2019)			
S_1(30 March)	2912	24948	28.47
S_2(30 May)	3350	26277	24.36
S_3(30 June)	2350	23738	46.47
CD@5%	7.12	23.12	0.16
Year (2021)			
S_1(30 March)	2755	23907	29.28
S_2(30 May)	3272	25437	24.71
S_3(30 June)	2302	24078	46.90
CD@5%	3.31	52.20	0.13

Table 3: Effect of sowing date on seed biochemical parameters

Sowing Date ↓	Catalase activity (μmoles mg^{-1} dry weight)	Peroxidase activity (μmoles mg^{-1} dry weight)	Dehdrogenase activity (O.D. g^{-1} ml^{-1})	Superoxide dismutase (μmoles mg^{-1} dry weight)
YEAR (2019)				
S_1(30 March)	41.43	0.317	2.32	59.32
S_2(30 May)	44.87	0.347	2.55	64.36
S_3(30 June)	32.95	0.268	1.96	50.62
CD@5%	0.05	0.001	0.01	0.84
Year (2021)				
S_1(30 March)	40.32	0.277	2.26	55.32
S_2(30 May)	44.36	0.297	2.52	59.36
S_3(30 June)	32.62	0.238	1.94	47.62
CD@5%	0.57	0.001	0.03	0.05

Table 4: Effect of sowing date on Seed quality parameters (Field emergence index and seedling establishment)

Sowing Date ↓	Field emergence index	Seedling establishment (%)
Year (2019)		
S_1(30 March)	20.35	82.87
S_2(30 May)	23.95	84.79
S_3(30 June)	17.11	79.03
CD@5%	0.06	0.19
Year (2021)		
S_1(30 March)	19.80	79.50
S_2(30 May)	23.67	82.73
S_3(30 June)	16.94	77.19
CD@5%	0.05	0.16

The results revealed that various field and laboratory parameters declined to the lowest value with the delay in the sowing time among the three sowings. The seed crop sown on 30th May (S_2) was found to be optimum time for cowpea seed production and recorded maximum seed yield, it further results in higher plant height, number of leaves, number of clusters per plant, number of pods per cluster, number of pods per plant, length of pod, number of seeds per pod and seed yield as compared to the early as well as delayed sowing. Sowing done on 30th March (S_1) showed up a decline and a further decline was observed in 30th June sowing in the above mentioned parameters. The probable reason for maximum yield in 30th May sowing may be due to the benefit of longer period available for plant growth and seed development. The relatively longer period available from sowing to maturity was very favourable for achieving higher yield. The decline in seed yield and quality due to early sowing may be due to less germination at lower temperature at nights which ultimately affected yield of the crop and decline in seed yield and quality in late June sowing may be the result of short growing period available for crop growth and seed development, indicated by 1000- seed weight, germination percentage, seedling length, seedling dry weight, vigour indices, field emergence index and seedling establishment.

Although there were substantial differences amongst cowpea genotypes in terms of pod features, there was no significant effect of sowing dates on individual pod weight. However, sowing dates and cowpea genotypes had an impact on green pod production per plant, with planting in April and May producing the highest green pod yield per plant. (Peksen, 2000) [31]. The results were also supported by Shiringani, (2011) [38], Saglam, (1997) [36], Mbong, (2010) [27], Fatokun *et al*., (2002) [11], Ibeawuchi *et al*., (2004) [14], Obadoni *et al*., (2009) [29], Dhital *et al*., (1998) [6], Ezeaku *et al*., (2015) [9].

Sowing date have significant effect on seed yield and quality also in other crops like soyabeans (Adjei-Twum, 1978; May *et al*., 1989) [2, 23], okra (Sayeed, 1988) [37], (Yadev, 1999; Incalcaterra *et al*., 2000) [42, 15], groundnut (Doku and Karikari, 1970) [7], and maize (Free *et al*., 1966; Pendleton, 1969) [12, 32].

Conclusion

On the basis of present investigation, it is concluded that to produce quality seed of cowpea, the crop should be sown in the last week of May. The maximum seed yield and better seed quality were found in 30th May sowing (S_2) followed by 30th March sowing (S_1) and minimum in 30th June sowing (S_3) for both the years.

Reference

1. Abdul-Baki AA, Anderson JD. Vigour determination in soybean seed by multiple criteria. Crop Science. 1973;13:630-633.
2. Adjei-Twum CC, Splittstoesser WF. Effect of environmental variation on growth and development and seed composition of soyabeans. Ghana Journal of Agricultural Science. 1978;11:171-178.
3. Anonymous: Economic Survey. 2006-07. Ministry of Finance (Economic Division), GOI, New Delhi. 16-18, 21; c2007.
4. Bensen TA, Temple SR. Trap cropping, planting date, and cowpea variety as potential elements of an integrated pest management strategy for *Lygus hesperus* in blackeyed cowpea. Crop Protection. 2008;27(10):1343-1353.
5. Cobley LS, Steele WM. An introduction to the botany of tropical crops. 2nd edition. London: Longman; c1976.
6. Dhital BK, Harding AH, Subedi M. Effect of planting dates on phenology, yield components and grain yield of determinate cowpea varieties in the low hills of Nepal. Nepal Agriculture Research Journal. 1998;2(1):27-34.
7. Doku EV, Karikari SK. Flowering and pod production of Bambara groundnut {Vigna subterranean (L) Verde} in Ghana. Ghana Journal of Agricultural Science. 1970;3:17-26.
8. Dornbos DL. Production environment and seed quality. In: Seed Quality. Basic Mechanisms and Agricultural Implication, Food Product Press, New York. 1995, 119-152.
9. Ezeaku IE, Mbah BN, Baiyeri KP. Planting date and cultivar effects on growth and yield performance of

cowpea (*Vigna unguiculata* (L.) Walp). African Journal of Plant Science. 2015;9(11):439-448.
10. Farmer Portal, 2018: https:farmer.gov.in/Success Report 2018-19.
11. Fatokun CA, Tarawali SA, Singh BB, Kormawa PM, Tamò M. Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World Cowpea Conference III held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4–8 September 2000. IITA, Ibadan, Nigeria; c2002.
12. Free GR, Winlelblech GS, Wilson HM, Bay GE. Time of planting in a comparison of photo-plant and conventional seed bed preparation for corn. Agronomy Journal. 1966;58:333-336.
13. Giannopolitis CN, Ries SK. Superoxide Dismutases: Occurrence in Higher Plants. Plant Physiology. 1977;59:309-314.
14. Ibeawuchi II, Tom CT, Ofoh MC, Opara CC. Effect of planting date, harvest stage and pod location on seed protein content and water uptake of Lima bean (*Phaseolus lunatus*). Pakistan Journal of Biological Sciences. 2004;7(6):963-965.
15. Incalcaterra G, Vetrano F, Stoffella PJ, Canttliffe DJ, Damato G. Effect of two sowing dates and plastic mulch on okra production. Acta Horticulture. 2000;533:329-336.
16. ISTA, International rules for seed testing. International Seed Testing Association, Zurich. Switzerland; c2011.
17. ISTA, International rules for seed testing. 2015;(1):1-276.
18. Kasul RT, Kadam NR, Pavithrakar NR, Khedekar RP. Improvement of seed quality in the marginal seed lots of cotton by using specific gravity separator. Seed Research. 2003;31(2):213-218.
19. Khatun A, Kabir G, Bhuiyan MAH. Effect of harvesting stages on the seed quality of lentil (*Lens culinaris* L.) during storage. Bangladesh Journal of Agricultural Research. 2009;34(4):565-576.
20. Kittock DL, Law AG. Relationship of seedling vigor to respiration and tetrazolium chloride reduction by germinating wheat seeds 1. Agronomy Journal. 1968;60(3):286-288.
21. Lopez-Bellido FJ, Lopez-Bellido RJ, Kasem KS, Lopez-Bellido L. Effect of planting date on winter Kabuli chickpea growth and yield under rainfed Mediterranean conditions. Agronomy Journal. 2008;100(4):957-964.
22. Maguire JD. Speed of germination-aid selection and evaluation for seedling emergence and vigor. Crop Science. 1962;2:176-177.
23. May ML, Caviness CE, Eldrge IL. Soybean response to early planting in northeast Arkansas. Arkansas Farm Research. 1989;38(4):5.
24. Maynard DN. Underutilized and underexploited horticultural crops. Hortscience. 2008;43(1):279.
25. Mazaheri D, Majnoon HN. Fundamental of Farming (Tehran University Press), 2005, 320.
26. Mazed K, Irin JI, Mollah M, Mahabub TS, Reza R. Effect of sowing time and seed treatment on growth, yield and quality seed production of chickpea (Bari Chola-6). International Journal of Research & Review. 2015;2(7):398-405.
27. Mbong GA, Akem CN, Alabi O, Emechebe AM, Alegbejo MD. Effect of sowing dates on yield and yield components of cowpea infected with scab. Asian Journal of Agricultural Sciences. 2010;2(2):57-62.
28. Mozumber SN, Moniruzzaman M, Islam MR, Alam SN. Effect of planting time and spacing on the yield performance of bush bean (*Phaseolus vulgaris* L.) in the eastern hilly area of Bangladesh. Legume Research. 2003;26(4):242-247.
29. Obadoni BO, Mensah JK, Ikem LO. Varietal response of four cowpea cultivars (*Vigna unguiculata* L.Walp) to different densities of guinea grass (Panicum maximum). African Journal of Biotechnology. 2009;8(20):5275-5279.
30. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR Publication, New Delhi; c1985.
31. Peksen A, Peksen E, Bozoglu H. Effects of sowing dates on yield and quality of cowpea (*Vigna unguiculata* L. Walp.) genotypes grown in greenhouse. In II Balkan Symposium on Vegetables and Potatoes. 2000;579:351-354.
32. Pendleton JW, Egli DB. Potential yield of corn as affected by planting date. Agronomy Journal. 1969;60:70-71.
33. Purseglove JW. Tropical crops: Dicots. Longman Group LTD. London; c1976. p. 321-328.
34. Rahman MM, Hampton JG, Hill MJ. Soybean seed yield as affected by time of sowing in a cool temperature environment. Journal of New Seeds. 2006;7:1-15.
35. Rao MB, Tanksale AM, Ghatge MS, Deshpande VV. Molecular and biotechnological aspects of microbial proteases. Microbiology and Molecular Biology Reviews. 1998;62:597-635.
36. Saglam N, Gebologlu N, Ece A, Fidan S, Yazgan A. Effects of different, sowing dates on harvesting date and yield of bean under plastic tunnels. In VIII International Symposium on Timing Field Production in Vegetable Crops. 1997;533:315-322.
37. Sayeed A. Effect of date of planting and insecticidal spray on the control of yellow vein mosaic of okra. MSc Thesis, Bangla. Agric. University, Mymensingh 2202, Bangladesh; c1988.
38. Shiringani RP, Shimelis HA. Yield response and stability among cowpea genotypes at three planting dates and test environments. African Journal of Agricultural Research. 2011;6(14):3259-3263.
39. Sinha AK. Calorimetric assay of catalase. Analytical Biochemistry. 1972;47(2):389-394.
40. Sumalatha GM, Uppar DS. Influence of date of sowing and foliar application of nutrients on crop growth and seed yield of soybean. The International Journal of Current Microbiology and Applied Sciences. 2019;8(1):2020-2032.
41. Yadav GL. Effect of sowing time, row spacing and seed rate on yield of cowpea under rained condition. Journal of Pulses Research. 2003;l16(2):157-159.
42. Yadev SK, Dhankhar BS. Performance of Varsha Uphar cultivar of okra as affected by the sowing dates and plant geometry. Vegetable Science. 1999;26:180-182.