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Effect of nutrient management on growth, yield attributes and yield of horsegram (*Macrotyloma uniflorum* L.)

NA Desai, MG Chaudhary, KR Solanki and MG Chaudhary

Abstract
A field experiment was conducted during *kharif* season of 2020 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the "Effect of nutrient management on growth, yield attributes and yield of horsegram (*Macrotyloma uniflorum* L.)". The experiment comprised of twelve treatments *viz.*, T_1: 75% RDF, T_2: 100% RDF, T_3: 125% RDF, T_4: 75% RDF + 500 ppm thiourea at branching, T_5: 75% RDF + 500 ppm thiourea at pre-flowering, T_6: 75% RDF + 500 ppm thiourea at branching and pre-flowering, T_7: 100% RDF + 500 ppm thiourea at branching, T_8: 100% RDF + 500 ppm thiourea at pre-flowering, T_9: 100% RDF + 500 ppm thiourea at branching and pre-flowering, T_{10}: 125% RDF + 500 ppm thiourea at branching, T_{11}: 125% RDF + 500 ppm thiourea at pre-flowering and T_{12}: 125% RDF + 500 ppm thiourea at branching and pre-flowering were evaluated in randomized block design replicating three times. Significantly higher plant height, number as well as dry weight of root nodules, number of branches per plant, number of pods per plant, pod length and number of seeds per pod of horsegram were recorded under treatment T_{12} which was found at par with treatment T_6. In the case of days to 50% flowering, days to maturity, seed index and harvest index, treatments did not affect significantly. Significantly, higher seed yield (770 kg/ha) and stover yield (2292 kg/ha) were achieved with application of 125% RDF + 500 ppm thiourea at branching and pre-flowering (T_{12}) which remained at par with treatment T_6.

Keywords: Horsegram, RDF, Thiourea, Branching, Pre-flowering

Introduction

Horsegram is a branched, trailing or sub erect and annual pulse crop. Its grain is used for human consumption as 'dal' as well as in preparation of so called 'rasam' and also as a concentrated feed for cattle. It may also be used as green manure. The United States National Academy of Sciences has identified this legume as a potential food source for the future (NAS, 1978) [11]. It performs well in all types of soil. It is least damaged by insect and disease despite high nutritional value. The crop requires least care and management during growing period. The crop can be stored safely for a longer period of time as the seeds are not damaged by stored grain pest. It is a food, feed and having medicinal value along with immense pertinence in sustaining and enhancing soil fertility by checking soil erosion and fixation of atmospheric nitrogen. Grain may be utilized in multifarious ways ranging from whole boiled seeds as dal to grounded flour mixed with main calorie sources like wheat flour. The seeds are used for those suffering from kidney stone which is the most prevalent problem in arid and semi-arid areas due to nagging poor quality of potent water. The sprouted grain and allied preparations of horsegram are extensively used for getting better sleep, curing irregular menstrual cycle and urinary problems in women, reducing acidity, curing whooping cough, constipation and piles. Horsegram is the fifth most widely grown pulse species in modern India. It is amongst the most ubiquitous archaeological pulse finds, indicating that it has been of widespread importance since the Neolithic period. In India, it is generally grown in Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, West Bengal, Bihar, Orissa, Rainfed areas of Uttar Pradesh, the tribal belts of Rajasthan and Gujarat. In India, horsegram covers an area of 0.4 million ha with production 0.247 million tonnes and productivity 618 kg per ha during 2017-18 (www.indiastat.com). In Gujarat, it is grown in punctuated pockets in tribal and difficult terrains of Dang, Surendranagar, Rajkot, Narmada, Dahod, Sabarkantha, Banaskantha and Panchmahal districts.

Material and Methods

The field experiment was laid out on Plot No. B-9 during *kharif* 2020 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). Geographically, Sardarkrushinagar is situated at 24º 19' North latitude and 72º 19' East longitude with an elevation of 154.52 metres above the mean sea level and situated in the North Gujarat Agro-climatic Zone. The climate of this region is subtropical monsoon type and falls under semi-arid region. In general, monsoon is warm and moderately humid, winter are fairly cool and dry, while summer is largely hot and dry.

The experimental field had an even topography with a gentle slope having good drainage. The soil of the experimental plot was loamy sand in texture, low in organic carbon (0.29%), available nitrogen (137.56 kg/ha), medium in available P_2O_5 (32.10 kg/ha) and available K_2O (250.50 kg/ha) with soil pH of 7.5. Electrical conductivity was very low showing that the soil was free from salinity hazard. The experiment comprised of twelve treatments *viz*., T_1: 75% RDF, T_2: 100% RDF, T_3: 125% RDF, T_4: 75% RDF + 500 ppm thiourea at branching, T_5: 75% RDF + 500 ppm thiourea at pre-flowering, T_6: 75% RDF + 500 ppm thiourea at branching and pre-flowering, T_7: 100% RDF + 500 ppm thiourea at branching, T_8: 100% RDF + 500 ppm thiourea at pre-flowering, T_9: 100% RDF + 500 ppm thiourea at branching and pre-flowering, T_{10}: 125% RDF + 500 ppm thiourea at branching, T_{11}: 125% RDF + 500 ppm thiourea at pre-flowering and T_{12}: 125% RDF + 500 ppm thiourea at branching and pre-flowering were evaluated in randomized block design replicating three times. The sources of fertilizers were Urea and DAP and recommended dose of fertilizers for crop is 20:40:00 NPK kg/ha. The horsegram variety 'Gujarat Dantiwada Horsegram 1' was sown on july 7th, 2020 at 45 cm row to row spacing by using recommended seed rate of 12 kg/ha. The average gross and net plot size were 5.0 m × 3.6 m and 4.0 m × 2.7 m, respectively. All other agronomic practices were adopted as per need of the crop.

Results and Discussion

Effect on growth attributes

Plant Population

The data exhibited in Table 1 showed that the plant population per metre row length at 20 DAS and at harvest were not significantly influenced due to different treatments which indicated that no adverse effect of RDF and thiourea were observed on germination of horsegram seed as well as on survival of horsegram plants.

Plant height (cm)

The data presented in Table 1 indicated that significantly higher plant height of 93.26 cm at harvest was recorded with treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering) over the other treatments, but it was at par with treatment T_6, T_8, T_9, T_{10} and T_{11}. Treatment T_1 (75% RDF) measured the lower plant height at harvest (64.70 cm). In general, as the rates of both nitrogen and phosphorus were increased through inorganic fertilizers, the plant height showed an increasing trend. The increase in plant height with the increments of the rates of both N and P might be due to the fact that both nutrients were involved in vital plant functions and contributed to enhanced growth in the height of the crop. These results were in accordance with the findings of Rathore *et al.* (2007) [14], Choudhary *et al.* (2008) [3] and Patel *et al.* (2013) [12]. The increase in plant height may be due to supplying of more nutrients at the critical growth stages *i.e.* branching and pre-flowering by foliar sprays of thiourea. The increase in plant height might be due to the increased vegetative growth under application of nitrogenous fertilizer as a foliar for photosynthetic activity. An increase in plant height due to application of foliar spray of thiourea was also observed by Garg *et al.* (2006) [5] and Bamniya (2009) [2].

Number and dry weight of nodules per plant at flowering

The result presented in Table 1 indicated that the number of nodules per plant was significantly influenced due to different treatments. The treatment T_{12} produced a significantly higher number of nodules per plant (25.10), but it was at par with treatment T_9 and T_{11}. The lowest number of nodules per plant (11.37) was noticed under treatment T_1. Treatments play a visible effect on the number of root nodules per plant at 55 DAS. The per cent increase in number of nodules under treatment T_{12}, T_{11} and T_9 over T_1 was to the tune of 121, 104 and 118, respectively. The higher number of nodules per plant may be due to better root growth of the plant providing more root surface for nodule formation. Moreover, application of phosphorus and nitrogen acceleration the nitrogen absorption power of the plant by increasing bacterial activity. The results were in accordance with the findings of Patel *et al.* (2013) [12] and Tripathi *et al.* (2013) [19].

Higher number of nodules also might be due to higher cytokinin activity of thiourea and vigorous vegetative growth of the crop having higher chlorophyll content of leaves might have helped to persist the photosynthates activity for longer period. Thus, these favourable influences of thiourea might have brought significant improvement in total number of nodules per plant. Similar results were also reported by Meena *et al.* (2018) [9] and Ravinder (2020) [15].

It is observed that application of 125% RDF along with 500 ppm thiourea at branching and pre-flowering (T_{12}) gave higher dry weight of root nodules per plant (11.40 mg) followed by T_{11} (10.70 mg) and T_9 (11.12 mg). The lowest dry weight (5.20 mg) of nodule was observed with treatment T_1 (75% RDF). Increase in number of nodules due to root proliferation and improvement in nodulation and nitrogen fixation by supplying assimilates to the roots resulted in increased dry weight of root nodules. Dry weight of nodules significantly increased because phosphorus has crucial role for nodulation as well as increasing the diameter of nodule and finally the fresh and dry weight of nodule. Foliar spray of thiourea might have increased rhizobial activity in the rhizosphere, which increased the number of root nodules and due to higher number of root nodules, fresh and dry weight of root nodules were increased. These results are in close agreement with the findings of Meena *et al.* (2018) [9] and Priyanka (2017) [13].

Effect on yield attributes and yield

Number of branches per plant

Number of branches per plant registered at harvest differed significantly due to various treatments. An application of 125% RDF along with 500 ppm thiourea at branching and pre-flowering (T_{12}) produced significantly more number of branches (14.89) per plant, but it was at par with T_6, T_9, T_{10} and T_{11} having the branches of 13.96, 14.10, 14.39 and 14.52, respectively. The minimum number of branches per plant

(10.32) was observed under T_1 (75% RDF). This might be due to thiourea has been reported to stimulate dark fixation of CO_2 in embryonic axes (Hernandez-Nistel *et al.* 1983) [6] which has resulted into improved photosynthetic efficiency and the photosynthates might have been utilized for the production of more number of auxiliary buds and ultimately resulted in more number of branches. These results are in close agreement with the finding of Jeengar (2012) [7].

Number of pods per plant

Treatments had a significant influence on the number of pods per plant. Significantly, more number of pods per plant (34.05) at harvest was obtained with treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering) which remained at par with treatment T_6, T_9, T_{10} and T_{11} having corresponding values of 31.76, 34.52, 32.47 and 32.90, respectively. Treatment T_1 (75% RDF) recorded a lower number of pods per plant (22.09). This could be ascribed to the adequate availability of N which facilitated the production of primary branches and plant height which in turn contributed for the production of a higher number of pods per plant. It is also due to the function of P fertilizer that promotes the formation of nodes in legumes and various enzymatic activities which control flowering and pod formation. More or less similar results were also observed by Choudhary *et al.* (2008) [3], Meena and Sharma (2013) [10] and Patel *et al*. (2013) [12].The beneficial role of thiourea sulphydryl compound in improving the translocation of photosynthates for yield formation has been also noted in pot study under laboratory condition at BARC, Mumbai which concluded that the efficiency of transport of labelled sucrose (14-C) from stem to pod of mustard was increased by 35.1-44.1 with foliar spray treatments as compared to unsprayed control (Srivastava *et al*., 2008) [18]. Its favourable effects on pod were also observed by Jeengar (2012) [7] and Priyanka (2017) [13].

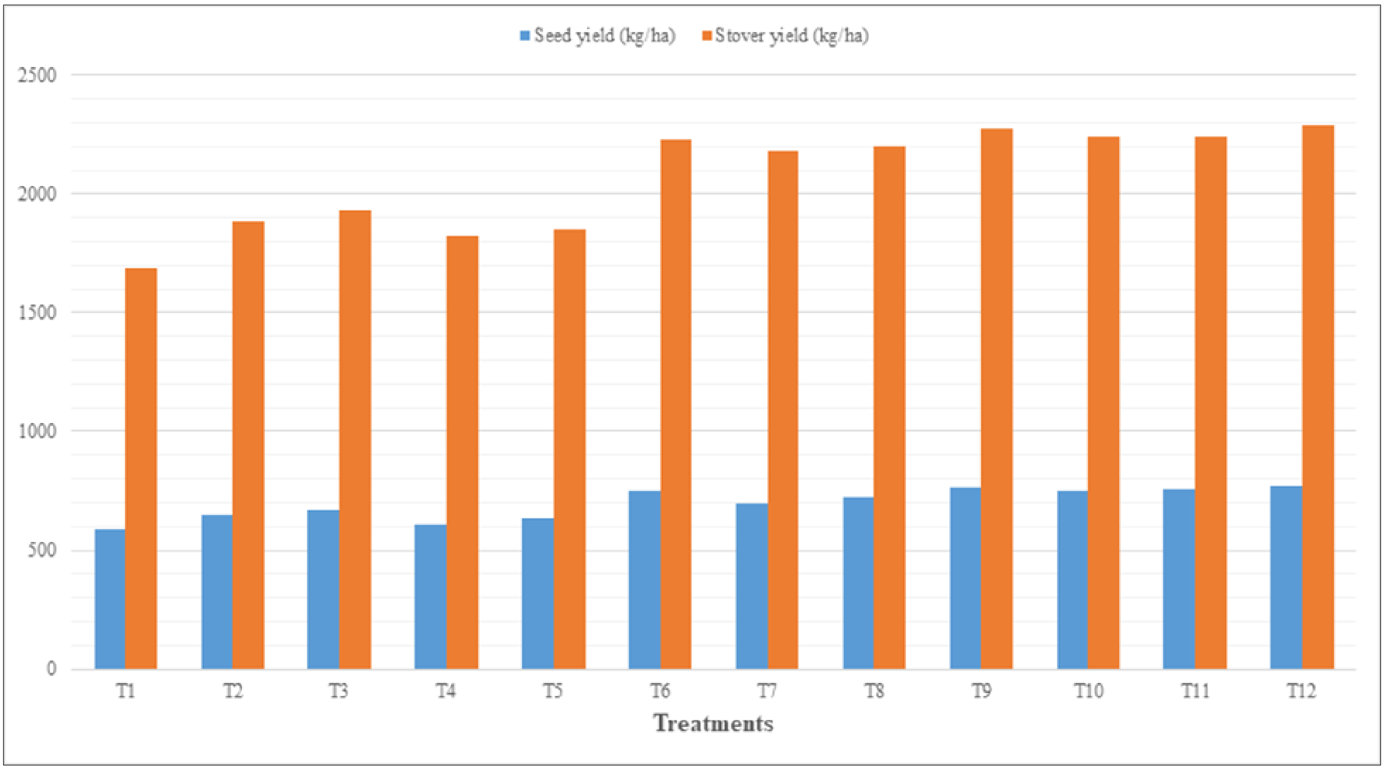

Fig. 1: Shows the difference of seed and stover yield

Pod length (cm)

Significantly maximum pod length (5.12) was noted with treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering) which stood at par with T_{10} and T_{11}. Treatment T_1 (75% RDF) recorded the minimum length of the pod (3.30 cm). The increase in length of pod may be a result of higher supply of plant nutrients during the flowering stage, which led to maximum pod length. Similar opinion was also given by Solanki (2003) [17].

Number of seeds per pod

Maximum number of seeds per pod (4.64) was found under the treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering) but it remained at par with treatment T_6, T_9, T_{10} and T_{11}. Significantly less number of seeds per pod (3.44) was noted with T_1 (75% RDF). The reason for more number of seeds per pod might be due to the balanced metabolism maintained continuously inside the plant to subsequent phases of growth, in legume and cereal seed and grain yield is the ultimate aim (Donald and Hamblin, 1976). These results were in close conformity with those of Meena and Sharma (2005) [8].

Seed yield (kg/ha)

Significantly maximum seed yield of 770 kg per ha was obtained with treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering), but it was found at par with treatment T_6, T_7, T_8, T_9, T_{10} and T_{11}.Treatment T_1 produced minimum seed yield of 590 kg per ha and it remained at par with treatment T_2, T_3, T_4 and T_5. The probable reason for increasing yield might be due to it seems to be directly associated with the concomitant increase in number of branches per plant, number of pods per plant and number of seeds per pod under these treatments. This might be the fact that excess assimilates stored in the leaves and translocated into seeds at the time of senescence, ultimately led to higher seed yield. The results of the present investigation are also corroborated by Rathore *et al.* (2007) [14] and Choudhary *et al.* (2008) [3].

Stover yield (kg/ha)

Maximum stover yield (2292 kg/ha) was registered with treatment T_{12} (125% RDF along with 500 ppm thiourea at branching and pre-flowering), but it was found at par with T_2, T_3, T_6, T_7, T_8, T_9, T_{10} and T_{11}. The application of chemical fertilizers has propounded effect on vegetative growth due to higher photosynthetic rates and chlorophyll contents of the plant. The increased availability of nutrients under these treatments might have improved the growth attributes which enhanced the photosynthesis and translocation of carbohydrates to sink site which ultimately led to positive increase in stover yield. Increase in biological yield as well as stover yield was the cumulative effect of growth parameters due to foliar sprays of thiourea also. These results also reconcile with Anitha *et al.* (2004) [1] and Jeengar (2012) [7].

Table 1: Effect of different treatments on plant population, height, nodule counts and dry weight of nodules

Treatments	Plant population per meter row length		Plant height at harvest (cm)	Number of nodules per plant at flowering	Dry weight of nodules (mg)
	20 DAS	At harvest			
T_1: 75% RDF	9.61	9.09	64.70	11.37	5.20
T_2: 100% RDF	10.12	9.46	74.10	14.09	6.30
T_3: 125% RDF	10.14	9.61	76.94	15.77	6.42
T_4: 75% RDF + 500 ppm thiourea at branching	9.73	9.28	73.58	11.62	6.00
T_5: 75% RDF + 500 ppm thiourea at pre-flowering	9.89	9.39	73.81	13.57	6.17
T_6: 75% RDF + 500 ppm thiourea at branching and pre-flowering	10.59	10.01	81.72	20.57	8.50
T_7: 100% RDF + 500 ppm thiourea at branching	10.34	9.69	78.94	17.07	7.30
T_8: 100% RDF + 500 ppm thiourea at pre-flowering	10.48	9.78	80.67	18.67	8.15
T_9: 100% RDF + 500 ppm thiourea at branching and pre-flowering	11.24	10.87	91.84	24.77	11.12
T_{10}: 125% RDF + 500 ppm thiourea at branching	10.63	10.07	83.08	21.47	9.20
T_{11}: 125% RDF + 500 ppm thiourea at pre-flowering	10.80	10.10	85.69	23.20	10.70
T_{12}: 125% RDF + 500 ppm thiourea at branching and pre-flowering	10.84	10.25	93.26	25.10	11.40
S.Em.±	0.33	0.35	4.84	1.06	0.39
C.D. at 5%	NS	NS	14.19	3.12	1.15
C.V.%	5.60	6.30	10.80	10.90	9.10

Table 2: Effect of different treatments on number of branches, pods, pod length, seeds per pod, seed and stover yield of horsegram

Treatments	Number of branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Seed yield (kg/ha)	Stover yield (kg/ha)
T_1: 75% RDF	10.32	22.09	3.30	3.44	590	1690
T_2: 100% RDF	11.81	25.07	3.70	3.61	650	1885
T_3: 125% RDF	11.90	25.74	3.67	3.87	671	1930
T_4: 75% RDF + 500 ppm thiourea at branching	10.72	22.98	3.39	3.51	610	1823
T_5: 75% RDF + 500 ppm thiourea at pre-flowering	10.77	23.80	3.46	3.57	637	1853
T_6: 75% RDF + 500 ppm thiourea at branching and pre-flowering	13.96	31.76	4.22	4.23	748	2230
T_7: 100% RDF + 500 ppm thiourea at branching	12.09	27.64	3.80	3.74	697	2181
T_8: 100% RDF + 500 ppm thiourea at pre-flowering	12.92	29.97	3.93	3.82	723	2202
T_9: 100% RDF + 500 ppm thiourea at branching and pre-flowering	14.10	34.52	4.50	4.40	764	2278
T_{10}: 125% RDF + 500 ppm thiourea at branching	14.39	32.47	4.65	3.99	750	2244
T_{11}: 125% RDF + 500 ppm thiourea at pre-flowering	14.52	32.90	4.80	4.30	758	2240
T_{12}: 125% RDF + 500 ppm thiourea at branching and pre-flowering	14.89	34.05	5.12	4.64	770	2292
S.Em.±	0.67	1.27	0.19	0.26	32.61	143.80
C.D. at 5%	1.96	3.75	0.58	0.75	95.64	421.75
C.V.%	9.40	8.00	8.90	11.70	8.30	12.30

Conclusions

Based on the results of one year experimentation, it is concluded that higher seed yield can be secured by horsegram with application of 75% RDF with 500 ppm thiourea at branching and pre-flowering.

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