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Effect of phosphorus level on growth and yield of sesame under custard apple based Agri-horticulture system

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Abstract
Application of 60 kg phosphorus revealed significantly tallest plant, maximum dry matter accumulation plant^{-1}, higher leaf area plant^{-1}, maximum number of branches plant^{-1} as compared to other phosphorus levels. The number of capsules plant^{-1} varied significantly due to different phosphorus levels. The number of capsules plant^{-1} was observed significantly highest with 60 kg phosphorus than rest phosphorus levels treatments. 60 kg phosphorus recorded significantly higher growth and yield attributes as compared to other treatments.

Keywords: Agroforestry system, phosphorus, growth attributes and yield

Introduction

Agroforestry is a land use that involves deliberate retention, introduction, or mixture of trees or other woody perennials in crop and or animal production fields to benefit from the resultant ecological and economic interactions. Custard apple (*Annona squamosa* L.), is also known as the sugar apple or custard apple (in India) or sweetsop. Custard apple is a fruit tree cultivated in different tropical countries around the world for its sweet and delicious fruits. This plant is a rich source of pharmaceutically important anticancer compound acetogenins (AGEs) (Liaw *et al*., 2010) [7]. In India, an estimated area and production of custard apple is 44,000 ha and 3,67000 tons. The area under custard apple in Karnataka is 1,800 ha with production of 13,400 tons and productivity of 7.4 tons ha^{-1} (NHB, 2017-18). The leaves are used as a vermicide, for treating cancerous tumors and are applied to abscesses, insect bites and other skin complaints. Rubbings of root-bark are used for toothache. This paper attempts to congregate the nutritional value, phytochemical composition, and medicinal uses of custard apple, (Nair *et al*., 2017) [9]. Sesame (*Sesamum indicum* L.) is an ancient oilseed crop of the world. It is recognized by various names like *Gingely, Til, Simsim, Gergelim, Biniseed* etc. It has earned a poetic label "Queen of Oilseeds" because the seeds have poly un-saturated stable fatty acids, which offer resistance to rancidity. Moreover, its seed is a rich source of edible oil (48-52%) and protein (18-25%). It consists of methionine; tryptophan, vitamin (niacin) and minerals. Hence sesame seeds are called "seeds of immortality". The expeller cake not only serves as good feed concentrate for livestock but also used as organic manure. It is highly esteemed as a livestock feed and also valued as an ingredient of poultry feed because of its high methionine content. India ranks first in area and production of sesame in the world. In 2017-18, current sesame production of India is 0.66 million hectare. The average yield of sesame in India is very low (426.1 kg ha^{-1}). It is widely cultivated in the states of Maharashtra, Uttar Pradesh, Rajasthan, Orissa, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, West Bengal, Gujarat and Karnataka. Gujarat is the leading Sesame producing state contributing 22.3% of total production, followed by West Bengal (19.2%), Karnataka (13.5%). The major management option for manipulating trees in agroforestry are based on the alteration of light (solar radiation) profile and moisture distribution. The option for managing trees are many e.g. pruning, coppicing, pollarding, lopping etc. Phosphorus is one of the seventeen essential nutrients required for plant growth. Despite its importance, it is limiting crop yield on more than 40% of the world's arable land (Balemi *et al.*, 2012) [2]. Phosphorus availability is a limiting factor for plant production in many agricultural soils (Fairhurst *et al*., 1999) [3]. In regions of the world without a history of use of phosphorus fertilizers, phosphorus deficiency is very common (Wild, 1988). A large portion of applied fertilizer phosphorus may be fixed to iron aluminium oxides and is then not available for plant uptake (Pal *et al.*, 2014) [11].

These facts make sound phosphorus management imperative, especially in situations where funds for fertilizer purchases are limited, as in tropical smallholder agriculture.

Material and Methods

Site Location: The present investigation was carried out at the Agronomy Research Farm of Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur which is situated in Vindhyan region (25º 10') latitude, 82º 37' longitude and altitude of 147 meters above mean sea level) occupying over an area of more than 1000 ha, where variety of crops like agricultural, horticultural, medicinal and aromatic plants are grown. Vindhyan region comes under rainfed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). The climate of Barkachha is typically semi-arid, and characterized by extremes of temperature both in summer and winter with moderate humidity and low rainfall. March to May is generally dry, maximum temperature in summer is as high as 45 ^{0}C and minimum temperature in winter fall up to 10 ^{0}C. The normal period for onset of monsoon in this region is the third week of June and lasts up to end of September or sometimes extends to the first week of October. The annual rainfall of Barkachha was 975 mm in 2018, out of 90% was contributed through south-west monsoon between July to September.

Experiment layout: The experiment was laid out during *kharif* season of the year 2018 in eleven years old custard apple plantation which was planted in August, 2006 at a spacing of 5 × 5 m. Experiment was laid out in Factorial randomized block design having four mulching (Control, Subabol, cassia, albezia).

Experimental crop

Sesame is one of the oldest oilseed crop and popularly known as Til. Hybrid variety of sesame RT-346 is recommended for dry land condition and mature in 80 to 82 days. Seeds are containing 46.4% oil. Average yield potential of this variety is 600-700 kg ha-1, which was sown under Agri-horticulture system of Custard apple in Vindhyan region.

Phosphorus dose application

Different levels of phosphorus were applied at the time of sowing at the rate of 40 kg ha^{-1} and 60 kg ha^{-1}. The source of phosphorus nutrient was SSP and calculated as per plots and incorporated in the soil at the time of sowing.

Results and Discussion

Plant height (cm): Analysis of data revealed that variations in plant height due to different mulches were found significant. Plant height significantly influenced by phosphorus levels at all growth level of sesame. As increased in phosphorus level plant height was also increased significantly. At all the growth stages (20, 40 and 60 DAS) highest plant height was obtained with the application of @ 60 kg ha^{-1} (Table 1). Phosphorus is the primary nutrient and plays a vital role in growth as well as development of plant. Phosphorus being an essential constituent of plant tissue significantly influences the plant height of crop (Kumar *et al.*, 2017) [4]. Phosphorus is the most important macronutrient that plants must obtain from soil. It is a major component of compound whose function related to growth, root development, flowering and ripening (Sampong *et al.*, 2010). [12]

Table 1: Effect of Phosphorus level on plant height.

Treatment	Plant Height (cm)		
Phosphorus levels (kg ha^{-1})	20 DAS	40 DAS	60 DAS
P1 (0)	11.23	56.70	67.97
P2 (40)	12.02	60.69	72.75
P3 (60)	12.61	63.80	76.28
S.Em±	0.17	0.85	1.06
CD (P=0.05)	0.50	2.48	3.12

Dry weight plant^{-1}: There was significant variation found in dry weight plant^{-1} due to phosphorus at all the growth stages of the observation. Dry weight of sesame as influenced by different phosphorus levels are presented in table 2. There was significant variation found in dry weight plant^{-1} at 20 DAS (1.09), 40 DAS (2.61), 60 DAS (6.31) was observed with 60kg phosphorus/ha which was significantly higher as compared to the rest of the treatment.

Table 2: Effect of Phosphorus level on dry weight.

Treatment	Dry weightplant^{-1}(g)		
Phosphorus levels (kg ha^{-1})	20 DAS	40 DAS	60 DAS
P1 (0)	0.98	2.32	5.62
P2 (40)	1.04	2.49	6.01
P3 (60)	1.09	2.61	6.31
S.Em±	0.01	0.04	0.09
CD (P=0.05)	0.05	0.11	0.25

Leaf area (cm): Leaf area plant^{-1} (cm) of sesame as affected by phosphorus levels are presented in table 3. At all the growth stages (20, 40 and 60 DAS) maximum leaf area plant^{-1}was recorded (58.33 at 20 DAS, 154.08 at 40 DAS, 253.91 at 60 DAS) with 60 kg ha^{-1} phosphorus level.

Table 3: Effect of Phosphorus level on leaf area (cm).

Treatment	Leaf area (cm)		
Phosphorus levels (kg ha^{-1})	20 DAS	40 DAS	60 DAS
P1 (0)	51.97	137.79	227.07
P2 (40)	55.63	146.95	242.16
P3 (60)	58.33	154.08	253.91
S.Em±	0.82	2.17	3.68
CD (P=0.05)	2.41	6.37	10.78

Number of primary branches plant^{-1}: Primary branches plant^{-1} as affected by phosphorus was found significant at all the crop growth stages. As influenced by phosphorus level, primary branches plant^{-1} also found statistically significant at all the growth states. At 40 DAS (10.72) and 60 DAS (14.64), significantly maximum number of primary branches plant^{-1} was found in application of 60 kg ha^{-1} phosphorus level as compared to rest of phosphorus levels.

Table 4: Effect of Phosphorus level on primary branches plant^{-1}.

Treatment	Primary branches plant^{-1}	
Phosphorus levels (kg ha^{-1})	40 DAS	60 DAS
P1 (0)	9.53	13.02
P2 (40)	10.20	13.96
P3 (60)	10.72	14.64
S.Em±	0.14	0.20
CD (P=0.05)	0.42	0.58

Yield attributes at harvestplant^{-1}: There was significant variations were observed due to different phosphorus level on number of capsule plant^{-1}. Number of capsule plant^{-1} increase with increase in phosphorus level and significantly maximum number (34.11) of capsule plant^{-1} were found with 60 kg ha^{-1} phosphorus. Critical analysis of data showed that application of 60 kg phosphorus ha^{-1} was recorded maximum capsule length (2.70) which was found statistically at par with each other (Table 5). Similar results were accordance with finding Arslan *et al.* (2018) [1] and Kumar *et al.* (2013).

Table 5: Effect of Phosphorus level on yield attributes at harvest

Treatment	Yield attributes at Harvest		
Phosphorus levels (kg ha^{-1})	No. of capsules (plant^{-1})	Capsule length (cm)	No. seeds (capsule^{-1})
P1 (0)	30.56	2.41	56.02
P2 (40)	32.53	2.58	59.78
P3 (60)	34.11	2.70	62.49
S.Em±	0.47	0.04	0.85
CD (P=0.05)	1.38	0.11	2.49

Table 6: Effect of Phosphorus level on yield and Harvesting Index

Treatment	Yield			Harvesting index (%)
	Seed yield (kg ha^{-1})	Stover yield(kg ha^{-1})	Biological(kg ha^{-1})	
Mulching				
M_1 (Control)	372.41	2374.06	2746.47	14.80
M_2(Subabool)	521.89	2936.92	3458.81	17.09
M_3(Cassia)	429.17	2766.48	3195.65	14.80
M_4(Albizia)	423.15	2583.03	3006.18	15.57
S.Em±	7.02	46.75	48.82	0.29
CD (*P*=0.5)	20.59	137.12	143.18	0.86

Conclusion

On the basis of experimental findings, the following conclusion may be drawn that application of 60 kg ha^{-1} phosphorus proved most effective for increasing growth and yield of sesame and achieved maximum net returns in the agro-ecological conditions of district Mirzapur, Uttar Pradesh.

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