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Review Article

RESPONSE OF THE INTERCROPPING AND PHOSPHORUS ON GROWTH AND YIELD OF MUSTARD CROP UNDER RAINFED CONDITION

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Abstract A field experiment was conducted at the Agricultural Farm of Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh -276128 (UP) during Rabi season of 2004-05 and 2005-06. The experiment comprising of twenty was laid out in a Split Plot Design with four replications. Treatment comprised viz. four cropping systems in main plot viz., Chickpea + Mustard (8:2), Chickpea + Mustard (4:1), Lentil + Mustard (16:2) and Lentil + Mustard (8:1) and five phosphorus level viz., 0, 20, 40, 60 and 80 kg/ha. The sown variety of chickpea, culture, Awarodhi, lentil Cultivar, Malika-75 and mustard, I-59 (Varuna) were used in the experiments. The soil of the experimental field was loamy in texture with pH of 8.5 – 9.0 and EC of 0.42 – 0.45 mmhos/cm at 25^{o}C during both the year of experiment, respectively. The results indicated that the growth characters, yield attributes, yield of mustard also influenced by intercropping and different level of phosphorus. The seed yield of mustard recorded higher (6.98 q/ha) under the intercropping of Lentil + Mustard (16:2) followed by Lentil + Mustard (6.35 q/ha) in row ratios of 8:1. The significantly higher yield of mustard was recorded (8.17 q/ha) with the application of 80 kg P_2O_5/ha which was closely significantly higher followed under the application of 60 kg P_2O_5/ha (7.61 q/ha).

Key words: Mustard, cultivar, intercropping, Treatment

Introduction

Intercropping and mixed cropping were originally practiced as an insurance against crop failure under rainfed and dry tracts of India, respectively. At present, the main objective of inter and mixed cropping are higher productivity per unit area in addition to stability in production and to meet the family requirement of cereals, pulses, oils and vegetables (Willey, 1979). As a result cereal cropping systems are no longer seem to be economically viable. At the same time, agriculture in rainfed areas where pulses are extensively grown in marred by frequent occurrence of drought and other a biotic stresses. In terms of vegetable oil, Oilseeds and edible oils are two of the most sensitive essential commodities. India is one of the largest producer of oilseeds in the world and this sector occupies an important position in the agricultural economy, accounting for the estimated production of 31.50 million tons of nine cultivated oilseeds during the year 2018-19 (November-October) as per 2nd Advance Estimates released by the Ministry of Agriculture on 28.02.2019. India contributes about 6-7% of the world oilseeds production (Anonymous, 2019). The demand of vegetable oil is also increasing due to increase in the population which, at present is being meeting out by the import of vegetable oil from other countries. This also suggests the need for increasing vegetable oil including mustard oil for feeding the increasing population. The scope for increasing area under oil seed crop is limited and therefore, inter and mixed cropping are one of the system of increasing the production oil seeds. Mustard has been found a very good crop for intercropping with *Rabi* pulses it has a great plasticity of plant (Patel *et al.* (1991). In major nutrient phosphorus plays an important role in increasing the yield of a crop. It has great importance in the transformation of energy in carbohydrate metabolism, tat metabolism in respiration. It promotes the growth of root nodules. It is closely related to all development process in plant Saini and Faroda (1998).

Methods and materials

Field experiments were conducted during *Rabi* seasons of 2004-05 and 2005-06 at the Agricultural Farm of the Shri Durga Ji Post Graduate College, Chandesar, Azamgarh (UP), India, situated at a latitude of 26°4'N and longitude of 83°11'E and at the elevation of 77.36 meter above the mean sea level. The experiment comprising of twenty treatments was laid out in a Split Plot Design with four replications. Treatment comprised four cropping systems in main plot viz., Chickpea + Mustard (8:2), Chickpea + Mustard (4:1), Lentil + Mustard (16:2) and Lentil + Mustard + Lentil (8:1) and five phosphorus level viz., Control, 20, 40, 60 and 80 kg/ha. The sown of main crop as chickpea of Awarodhi and lentil of Mallika-75 and sub crop as mustard of Varuna were used in the experiment

The soil of the experimental field was loamy in texture with pH of 8.5 – 9.0 and EC of 0.42 – 0.45 mmhos/cm at 25^0C during both the year, respectively. The Annual precipitation was 1200 mm. Out of the total rainfall 90% was received in rainy season and rest occurred in winter season. The sowing of pure crop of mustard was done in row 45 cm apart @ 5 kg seed/ha. Phosphorus level as per treatments were basically applied. Recommended dose of fertilizers was used 120 kg N and 40 kg K_2O per ha. The pooled analysis for all observations was done according to the methods suggested by Yates and Cochran (1938).

Result and Discussion

(a) Effect of cropping system and phosphorus on growth of Mustard

Plant population/m^2 after thinning and at harvest was significantly affected by chickpea + mustard and lentil + mustard row ratio. Plant population observed significantly higher with lentil + mustard row ratio of 8:1 and 16:2 (32.67 and 25.78 per plot) and (53.33 and 41.20 thousand/ha) at harvest. Primary branches'/plant were recorded lentil + mustard (16:2), (5.52) and lentil + mustard (8:1), (4.91), secondary branches/plant were recorded significantly higher (13.40) per plant in lentil + mustard (16:2) followed by lentil + mustard (8:1), (11.84), tertiary branches/plant significantly higher (15.05) were recorded in lentil + mustard (16:2) followed by lentil + mustard (8:1), (14.40). The plant height was recorded significantly higher (168.73 cm) in row ratio of lentil + mustard (8:1) row ratio of (16:2), (158.02) at harvest. The fresh weight/plant (gm) was recorded significantly higher (239.88) in lentil + mustard row ratio of (8:1) followed by lentil + mustard in row ratio of (16:2), (237.87). The dry weight (gm)/plant was recorded significantly higher (75.97) in lentil + mustard (8:1) and followed by lentil + mustard (16:2), (74.92) at harvest. It was observed that the significantly maximum plant population of mustard (32.94 thousand/ha) were recorded under intercropping of lentil + mustard (8:1) and significantly minimum was recorded (22.98 thousand/ha) in chickpea + mustard (8:2). The plant population of mustard significantly higher (29.66/m^2) under the application of 80 kg P_2O_5 and minimum (20.65/m^2) without application of phosphorus. Number of primary branches/plant of mustard significantly higher (5.52/plant) is lentil + chickpea (16:2) minimum (4:35/plant) under the chickpea + mustard (4:1). The secondary branches/plant of mustard also influenced by intercropping mustard with chickpea and lentil. The significantly higher number of secondary branches recorded under lentil +mustard (13.40/plant) in row ratios of 16:2 followed by lentil + mustard (11.84/m^2) in row ratios of 8:1 and minimum was recorded (10.83/plant) under intercropping system of chickpea + mustard (4:1). The significantly maximum tertiary branches/plant (15.05) were recorded in lentil + mustard (16:2) which was at par to lentil + mustard (8:1) (14.40) The number of tertiary branches of mustard were recorded significantly higher (15.70/plant) with application of 80 kg P_2O_5)/ha but it was significantly at par to with application of 60 kg P_2O_5/ha (15.14/plant). The minimum was recorded (10.31/plant) without application of phosphorus. The fresh and dry weight (g/plant) were also effected by intercropping system and different doses of phosphorus. The significantly maximum fresh weight (156.25 q/plant) of mustard was recorded when mustard intercropped with lentil in row ratios of (8:1) but it was significantly at par with intercropping of mustard with lentil (155.28 gm/plant) in row ratios of 16:2. The significantly maximum fresh weight (157.70 g/plant) was recorded under the application of phosphorus @ 80 kg P_2O_5/ha, which was significantly at par to with application of with application of 60 kg P_2O_5/ha (156.58 gm/plant). The minimum fresh weight (148.52 gm/plant) recorded without application of phosphorus. The similar trend was also recorded in case of dry weight and plant height of mustard.

Mustard was intercropped with chickpea and lentil by replacing their two rows after 8^{th}, 5^{th} and 9^{th} row respectively. Just to find out phosphours requirement of chickpea and lentil in different row ratios in association of mustard. It is evident by the accumulate of dry matter per plant at maturity of the crop by Gangasaran and Giri (1985). The adverse effect was found to be reduced as the proportionate number of rows of lentil were increased. It is clear from the results that dry matter accumulation per plant in mustard was 60.39 per cent up to 90 day stage. Growth of mustard measured in terms of branching was found to be increased upto the highest tested dose of 80 kg P_2O_5/ha positive effect of phosphorus on growth of mustard crop has been reported by Singh *et al*. (1997), Singh and Singh (1998), Tripathi *et al*. (2005).

(b) Effect of cropping system and phosphorus on yield attributes of mustard:

Number of siliquae on primary branches also influenced by inter cropping system and different doses of phosphorus. The maximum number of siliquae on primary branches were recorded significantly higher (145.22) in lentil + mustard (16:2) and followed by lentil + mustard (142.00) in row ratios of (8:1) and significantly minimum in chickpea + mustard (137.62). in row ratios of (8:1). The maximum number siliquae (146.93) on primary were recorded with the application of 80 kg P_2O_5/ha followed by application of 60 kg P_2O_5/ha (145.47). The significantly minimum (134.18) were recorded under without application of phosphorus. In case of number of siliquae on secondary branches it was observed that the significantly higher (213.55) under the cropping system of lentil mustard (16:2), but significantly at par to all other intercropping system. The application of phosphorus also increased the number of siliquae on secondary branches

Table1. Pooled as effect of cropping system & phosphorus on growth attributes of mustard

Treatments	Plant population (m^2)	Primary branches/ Plant	Secondary branches/ plant	Tertiary branches/ plant	Branches/ plant	Plant height (cm)	Fresh weight (g)	Dry weight (g)
Cropping System:								
Chickpea + Mustard (8:2)	22.98	4.57	11.42	13.34	29.15	154.60	153.94	45.09
Chickpea + Mustard (4:1)	23.90	4.35	10.83	12.41	27.72	151.45	151.42	43.55
Lentil + Mustard (16:2)	24.72	5.52	13.40	15.05	33.69	158.02	155.28	46.38
Lentil + Mustard (8:1)	32.94	4.91	11.84	14.40	30.86	168.73	156.28	47.27
S.E. (d)	0.49	0.09	0.24	0.30	0.45	1.24	0.69	0.26
C.D. at 5%	1.03	0.20	0.51	0.63	0.96	2.62	1.45	0.55
Phosphorus (kg/ha):								
0	20.65	3.63	9.12	10.31	22.69	148.51	148.52	41.53
20	24.89	4.48	10.75	13.72	28.52	153.92	153.00	44.63
40	26.59	4.96	12.26	14.22	31.65	157.01	155.33	46.32
60	28.79	5.39	13.11	15.14	33.57	159.51	156.58	47.28
80	29.66	5.72	14.11	15.70	35.35	160.78	157.70	48.07
S.E. (d)	0.53	0.13	0.26	0.36	0.62	2.33	1.01	0.49
C.D. at 5%	1.04	0.27	0.53	0.72	1.23	4.57	1.98	0.96

Table-2. Pooled as effect of cropping system & phosphorus on yield attributes of mustard

Treatments	Siliquae on primary branches	Siliquae on secondary branches	Siliquae on tertiary branches	Siliquae/ plant	Seeds/ siliquae	Weight of siliquae/ plant (g)	Weight of seed/ plant (g)	Test weight (g)
Cropping System:								
Chickpea + Mustard (8:2)	140.92	212.08	57.15	410.15	14.30	40.36	23.26	4.16
Chickpea + Mustard (4:1)	137.62	210.16	55.74	403.52	13.19	39.61	21.93	4.65
Lentil + Mustard (16:2)	145.52	213.55	59.54	418.61	14.72	43.21	24.98	4.41
Lentil + Mustard (8:1)	142.00	212.20	59.14	413.34	13.66	43.27	24.40	4.28
SE (d)	1.50	2.50	0.51	4.46	0.19	0.37	0.26	0.10
C.D at 5%	3.16	5.25	10.07	9.38	0.41	0.78	0.50	0.21
Phosphorus (Kg/ha)								
0	134.18	207.25	54.25	395.61	9.31	35.68	16.33	3.66
20	138.80	210.75	55.56	405.11	13.28	39.83	22.23	4.03
40	142.18	212.79	58.41	413.38	14.90	42.96	25.04	4.35
60	145.47	214.12	60.37	419.96	15.82	44.43	26.95	4.48
80	146.93	215.07	60.86	422.86	16.52	45.13	27.65	4.58
SE (d)	1.35	3.69	0.84	4.54	0.29	0.57	0.34	0.16
C.D at 5%	2.67	5.25	1.67	8.99	0.58	1.13	0.68	0.32

Table-3: Pooled as effect of cropping system & phosphorus on yields of mustard

Treatments	Biological yield (q/ha)	Seed yield (q/ha)	Stover yield (q/ha)
Cropping System:			
Chickpea + Mustard (8:2)	18.88	5.68	21.62
Chickpea + Mustard (4:1)	17.52	4.94	20.68
Lentil + Mustard (16:2)	21.24	6.35	22.83
Lentil + Mustard (8:1)	22.42	6.98	25.15
SE (d)	0.20	0.09	0.21
C.D at 5%	0.43	0.19	0.45
Phosphorus (kg/ha)			
0	13.28	2.42	11.86
20	19.12	5.10	19.56
40	21.29	6.62	25.45
60	23.16	7.61	27.63
80	23.73	8.17	28.33
SE (d)	0.35	0.16	0.3
C.D at 5%	0.70	0.32	0.74

upto 80 kg P_2O_5/ha (215.07) and minimum were record (207.25) without application of phosphorus. Number of seed/siliquae also influenced intercropping system and different doses of phosphorus. The significantly higher (14.72) under the inter cropping of lentil + mustard (16:2) and minimum were recorded (13.19) intercropping of chickpea + mustard (4:1).

The number of seeds/ siliquae were recorded higher (16.52) under the application of 80 kg P_2O_5/ha followed by with the application of @ 60 kg P_2O_5/ha (15.82) and minimum (9.31) were recorded without application of phosphorus. The weight of siliquae/plant recorded significantly higher (43.27 gm/plant) under the intercropping system of lentil + mustard (8:1) and minimum (39.61 gm/plant) in chickpea + mustard (4:1). The rate of phosphorus also influenced weight of siliqure/plant. The significantly higher (45.13 gm/plant) with application phosphorus @ 80 kg P_2O_5/ha followed by with the application of 60 kg P_2O_5/ha (44.43 gm/plant) and significant minimum (16.33 gm/plant) recorded without application of phosphorus. The similar trend was recorded weight of seed/plant intercropping system as whole and different doses of phosphorus. The test weight higher recorded (4.65 gm) under the intercropping system chickpea + mustard (4:1) and minimum (4.28 gm) was recorded lentil + mustard (8:1). Test weight of mustard significantly at par each other. The doses of phosphorus increasing with increasing test weight. The higher (4.58 gm) test weight was recorded under the application of 80 kg P_2O_5/ha and minimum (3.66 gm) recorded without application of phosphorus.

Yield attributes like number and weight of siliquae and different branches per plant were found to be increased with increase in the rate of phosphorus and this resulted into positive effect on grain weight per plant without affecting the number of grains per siliquae and size of grains. The positive effect of phosphorus application on the yield attributes in mustard upto 80 kg P_2O_5/ha has also reported by Singh *et al.* (1997), Singh and Singh (1998), Chand *et al.* (2004), Tigga *et al.* (2004) and Tripathi *et al.* (2005).

(c) Effect of yield of mustard:

The seed yield of mustard recorded higher (6.98q/ha) under the intercropping of lentil + mustard (8:1) followed by lentil + mustard (6.35 g/ha) in row ratios of 16:2. The significantly minimum (4.94 q/ha) yield recorded when inter cropped with chickpea + mustard in row ratios of 4:1. The significantly higher yield recorded (8.17 q/ha) with the application of 80 kg P_2O_5/ha which was at par with the application of 60 kg P_2O_5/ha (7.61 q/ha) and significantly minimum yield was (2.42 q/ha) without application of phosphorus. The stover yield also influence by different intercropping systems and doses of phosphorus kg/ha. It was observed that the significantly higher yield (25.15 q/ha) in lentil + mustard (8:1) followed by lentil + mustard (16:2) (22.83 q/ha) and minimum yield recorded (20.68 q/ha) under chickpea + mustard (4:1). The different doses of phosphorus also influenced the yield of mustard. It was

observed that the significantly higher yield stover yield (25.15 q/ha) in lentil + mustard (8:1) followed by lentil mustard 16:2 (22.83 q/ha) and minimum yield recorded (20.68 q/ha) under chickpea + mustard (4:1). The different doses of phosphorus also influenced the stover yield of mustard. It was observed that the significantly higher yield (28.33 q/ha) were recorded under the application of 80 kg P_2O_5/ha followed by with the application of 60 kg P_2O_5/ha (27.63 q/ha). The significantly minimum yield was recorded (11.86 q/ha) without application of phosphorus. These results support the finding of Bahadur *et al.* (2002).

Refereces

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