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Chickpea (*Cicer arietinum* L.) Based Intercropping System with Rapeseed (*Brassica napus* L.) on Growth, Yield and Competition Indices

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Abstract A field experiment was conducted during the winter season of 2013-2014 and 2014-2015 to evaluate the production potential, biological feasibility and economic viability of intercropping of chickpea (*Cicer arietinum* L.) with rapeseed (*Brassica napus* L.) in row ratios of 1:1, 2:1, 3:1, 4:1, 5:1`, 2:2, 3:2, 4:2 and 5:2 under rainfed conditions of Manipur. Sole crop of chickpea and rapeseed proved superior in terms of yield and yield attributes than the intercropping systems. Chickpea in association with rapeseed in 3:1 row proportion recorded significantly more pods per plant, seeds per pod, and 1,000-grain weight and also higher grain and straw yield. Land equivalent ratio (LER) was observed highest (1.42) in 3:1 row proportion and was found to be significantly higher than sole chickpea and sole rapeseed. Sole rapeseed was recorded with significantly higher chickpea equivalent yield. Monetary advantage of chickpea + rapeseed was highest (Rs 12,950.46) in 3:1 row proportion followed by chickpea + rapeseed (Rs 11, 179.69) intercropping in 4:2 row proportions.

Keywords Chickpea, Rapeseed, Competition functions, Economics, Intercropping.

Introduction

Chickpea (*Cicer arietinum* L.) and rapeseed (*Brassica napus* L.) are grown in sole as well as in mixed stands because of their diverse morphology, growth rhythm and similar climatic requirements. Chickpea or gram is the most important winter grain legume in India belonging and is the third most important pulse crop that plays a vital role in global agricultural economy [1]. Chickpea constitutes 38% area and 50% production of pulses in India. Chickpea provides a high quality protein (22%), mainly to the people in developing countries and it can play a key role to alleviate protein-energy malnutrition. Rapeseed mustard stands second in edible oil production after soybean in India.

Rapeseed-mustard called as oilseed brassicas, has been found successfully intercropped mainly with different crops viz. chickpea, lentil, sugarcane, potato, wheat, under various agro climatic zones of the country. The traditional practice of mixed cropping has gained popularity in recent years in the form of intercropping with a suitable modification in planting

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pattern. Conceptually, intercropping system helps for risk avoidance from epidemic of insect-pest and disease, and overcome the effect of adverse environmental conditions in agro-climatologically unstable regions along with better utilization of solar radiation and inputs like fertilizer and water compared to crops in sole system. Diversification of cropping systems is necessary to get higher yield and returns to maintain soil health, preserve the environment and meet the daily requirement of food and feed for human and animals. Growing of Indian mustard as an intercrop in chickpea is a common practice. If recommended row ratio of chickpea with oilseeds like rapeseed-mustard for a specific area is adopted then farmers could utilize applied and available resources more efficiently and effectively on sustainable basis. Hence the present experiment was undertaken to evaluate the comparative performance of intercropped chickpea with rapeseed and economics of these intercropping system under rainfed conditions of Manipur.

Materials and Methods

The experiment was conducted during the winter season of 2013-2014 and 2014-2015 at the Research Farm of College of Agriculture, Central Agricultural University, Imphal. The experimental site is situated at $24^0 46´´$N latitude and $93^0 54´´$ E longitude at an altitude of 774.5 meters above mean sea level. The soil of the experimental site is well drained clay loam soil with pH 5.4 (1:2.5 soil water)and contained 0.58% organic C, 279.53 kg/ha available N, 18.45 kg/ha available P, 225.06 kg/ha available K.

The experiment consisting of 11 treatments was laid out in randomized complete block design with three replications. The treatment consists of two sole treatments of chickpea cv "JG-14" and rapeseed cv "YSH-401", along with nine intercropping system of chickpea and rapeseed in replacement series in row ratios of 1:1, 2:1, 3:1, 4:1, 5:1, 2:2, 3:2, 4:2 and 5:2. The rows of chickpea or rapeseed were adjusted according to row ratio of the treatments. The fertilizers in sole stands and in intercropping system were applied at the rate of 20 kg N, 40 kg P, 20 kg K/ha respectively. The sources of fertilizers were urea, single super phosphate and muriate of potash. The crops of chickpea and rapeseed were sown in the first week of December at the row space of 30 cm,.using 60 kg/ha and 4 kg/ha seed rate respectively. All the crops were harvest 120 days after sowing in both the year of experimentation. The results of both the years were more or less similar and hence the data of 2 years were pooled an analyzed statistically. For assessing the economic viability of the system, land use and production efficiencies were computed by using the formula [2].

Results and Discussion

Crop productivity

Sole crop of chickpea proved superior in terms of yield attributes than the intercropped chickpea. Pods per plant, seeds per pod, and 1,000-grain weight of chickpea decreased significantly in intercropping system, depending on the nature of intercrop and their row arrangement (Table 1). Chickpea in association with rapeseed in 3:1 row proportion recorded significantly more pods per plant, seeds per pod, and 1,000-grain weight. Maximum reduction in yield attributes was recorded in chickpea intercropped with rapeseed in 1:1 row proportion due to greater shading and competition effect of the intercrops on

Table 1. Yield components and yield of sole chickpea and Intercrops as influenced by intercropping system (average data of 2 years).

Treatments	Pods/ plant	Seeds/ pod	1000 grain weight (g)	Straw yield (kg/ha)	Grain yield (kg/ha)
Sole chickpea	14.5	2.1	204.0	1262.81	959.10
Intercropping system chickpea: mustard					
1:1	10.7	1.0	184.4	905.98	611.40
2:1	13.4	1.1	199.3	1168.11	813.41
3:1	14.1	1.6	201.8	1240.16	933.41
4:1	11.3	1.3	195.2	948.36	684.31
5:1	10.9	1.1	188.5	1020.76	677.94
2:2	12.1	1.2	193.5	1087.24	745.48
3:2	13.8	1.2	199.4	1152.53	818.20
4:2	13.6	1.5	197.1	1182.73	864.41
5:2	13.3	1.1	195.0	1190.33	863.94
SEm (±)	0.70	0.22	6.83	22.43	13.69
CD (p=0.05)	2.11	0.65	20.49	67.26	41.05

Table 2. Yield components and yield of sole mustard and intercrops as influenced by intercropping system (average data of 2 years).

Treatments	Siliqua/ plant	Seeds/ siliqua	1000 grain weight (g)	Straw yield (kg/ha)	Grain yield (kg/ha)
Sole chickpea	22.5	25.0	4.1	1062.09	2025.86
Intercropping system chickpea : mustard					
1:1	16.5	16.1	3.4	439.75	886.87
2:1	17.1	18.2	3.5	485.88	975.07
3:1	17.7	17.6	3.6	467.46	942.61
4:1	15.1	15.4	3.4	325.73	643.18
5:1	14.7	15.5	3.5	323.55	619.75
2:2	22.7	18.4	3.8	496.50	923.33
3:2	17.8	17.5	3.6	474.04	904.47
4:2	20.0	17.9	3.7	483.76	909.15
5:2	14.6	16.2	3.3	401.41	788.70
SEm (±)	1.09	1.05	0.15	13.97	13.84
CD (p=0.05)	3.26	3.16	0.46	41.89	41.51

Table 3. Competition functions and monetary advantages of chickpea and rapeseed-mustard in intercropping system (average data of 2 years).

Treatments	Chickpea equivalent yield	Land equivalent ratio	Aggressivity (A) chickpea	Competitive ratio (CR) of chickpea	Monetary advantage (Rs/ha)
Sole chickpea	959.10	1.00	-	-	-
Sole rapeseed	1037.00	1.00	-	-	-
Intercropping system chickpea : mustard					
1:1	429.36	1.05	0.22	1.54	1630.52
2:1	474.40	1.31	-0.03	0.93	9610.54
3:1	456.42	1.42	-0.12	0.74	12950.46
4:1	318.04	1.02	-0.13	0.58	646.06
5:1	315.91	1.01	-0.14	0.47	381.87
2:2	484.78	1.25	0.15	1.67	7702.47
3:2	462.84	1.30	0.06	1.28	9394.07
4:2	472.34	1.36	0.00	0.99	11179.69
5:2	391.92	1.28	-0.01	0.95	8702.21
SEm (±)	14.03	0.10	0.02	0.03	619.9
CD (p=0.05)	41.39	0.30	0.06	0.08	1858.5

chickpea.

Intercropping significantly reduced the grain and straw yields of chickpea compared with those of sole chickpea due to more interspecific competition. Among row proportions, the increase in the grain yield with 3:1 row proportion could be further attributed to higher yield attributing parameters namely pods per plant, 1000 grains weight and number of grains per pods because the depressing effect of intercrops on chickpea was minimized due to lesser number of intercrop rows and greater space occupied by chickpea. Maximum reduction in productivity was recorded in 1:1 chickpea + rapeseed row proportion due to lower yield attributes, irrespective of crop.

Similarly sole rapeseed recorded significantly higher yield attributing characters such as number of seeds per siliqua and 1,000 seeds weight over various row ratios of intercropped rapeseed (Table 2). Among the row proportions, rapeseed in association with chickpea in 2:2 row proportion recorded significantly highest number of siliqua per plant, seeds per siliqua, and 1000-grain weight. Number of siliqua per plant was found highest in 2:2 row proportion compared to sole rapeseed. These results are in conformity with earlier findings [2]. Thus, in intercropping, rapeseed has the advantage as it is more exposed to the sun and component crop suffers more as it grows under the rapeseed canopy. Mustard as sole crop recorded significantly higher seed yield over intercropped mustard. The sole crops of chickpea and rapeseed proved superior to all the intercropping systems. Sole rapeseed was recorded with significantly higher chickpea equivalent yield due to higher yield of rapeseed and its market price coupled with better utilization of resources by the sole crop in the intercropping system. These results agree with the findings earlier [2].

Competition functions

Intercropping of chickpea with rapeseed resulted in land equivalent ratio (LER) > 1, compared to sole chickpea and sole rapeseed indicating its advantage or biological efficiency and suitability of the practice in quantitative term (Table 3). Land equivalent ratio

(LER) differed significantly from other treatments and was observed highest (1.42) in 3:1 row proportion and was found to be significantly higher than sole chickpea and sole rapeseed. The obvious reason for yield advantage in intercropping system was due to the fact that the component crops have combined effect of better utilization of growth resources than sole cropping of companion crops and converting them more efficiently resulting in higher yields per unit area than that produced by the sole crops [3, 4]. The association of chickpea with rapeseed in 5:1 row ratio gave lower LER (1.01), indicating less efficient system. Competitive ratio (CR) was observed lowest in 5:1 row proportion (0.47) compared to other intercropping systems. This might be due to the companion crop chickpea appeared less competitive than rapeseed, giving lower value of competitive ratio. Greater the numerical value of aggressivity (A) bigger is the difference in competitive ability and bigger difference between actual and expected yield. This means that chickpea proved to be the dominated crop in 2:1, 3:1, 4:1, 5:1, 5:2 row proportions with negative value and dominant crop in the rest all other treatments with positive aggressivity value. Zero value was obtained in 4:2 row proportion which means that component crops viz,. chickpea and rapeseed are equally competitive.

Economics

Table 3 shows that intercropping had a higher economic advantage over sole cropping. Similar observations were also reportd earlier [5]. Monetary advantage based on LER indicated superior economic viability of chickpea + rapeseed was highest (Rs 12950.46) in 3:1 row proportion which was significantly higher than sole cropping of component crops and other intercropping treatments. This was followed by chickpea + rapeseed (Rs 11,179.69) intercropping in 4:2 row proportions. The higher the MAI value themore profitable is the cropping system [6]

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