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# Response of intercropping and different row ratios on growth and yield of wheat (Triticum Aestivum) under rainfed condition of kaymore plateau

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**ABSTRACT:** *A field experiment was conducted at Krishi Vigyan Kendra, Deendayal Research Institute, Majhagawan, Satna in rabi season 2013 and 2014 to study the response of wheat (Triticum aestivum) based intercropping(wheat+chickpea, wheat+linseed and wheat+mustard) and different row ratios (2:2, 4:2 and 6:2) under rainfed conditions of Kaymore Plateau. Intercropping reduced the values of growth parameters and yield attributes of chickpea (Cicer arietinum), linseed (Linum usitatisetum) and mustard (Brassica campestris) compared with their sole crops. Intercropping with wheat +chickpea in 2:2 row ratio recorded significantly higher wheat equivalent yield (WEY) 46.04 q/ha, land equivalent ratio (LER) 1.36,net income Rs.42429/ha and benefit :cost ratio 3.64 in comparison of sloe crop of wheat 39.94 q/ha, 1, Rs.38882/ha and 3.45, sloe crop of chickpea 27.62 q/ha, 1, Rs.19146/ha and 1.71, sloe crop of linseed 26.82 q/ha, 1, Rs.19366/ha and 2.09, sloe crop of mustard 25.40 q/ha, 1, Rs.19589/ha and 2.15,respectively.*

**Keywords:** Intercropping, land equivalent ratio, monetary return, row proportion wheat equivalent yield

## I. INTRODUCTION

Wheat is a major staple food crop of India and is of paramount importance for food security of the country. It has been a staple food with the level of consumption largely unaffected by changes in its prices and the price of substitutes like rice, maize and millets. The productivity of wheat in rain fed condition is quite low, which opens the scope of intercropping with pulses or oilseeds in wheat for efficient land utilization. Intercropping system, designed on principle of scientific base on crop production, hold a great promise in increasing the land productivity under Indian conditions (Hosmani et al, 1990). Inter cropping results in more efficient use of solar energy and harnessing benefits of positive interactions in crop associations (Yadav et al, 1998). Inter cropping has been found equally beneficial in wide spread crops like maize, sorghum, castor etc (Balyan, 1997) and in densely sown crops like wheat, barley etc (Mandal et al, 1997). The prime objective of intercropping is to reduce the risk due to vagaries of monsoon, but it has now been changed to augment the productivity per unit area and time.

The success of inter cropping depends mainly on the use of compatible crops and their suitable row proportions. Inter crops with main crops are grown in two ways of additive and replacement series. In additive series, additional population of intercrops is adjusted with full population of main crop per unit area, while in replacement series, population or rows of main crops are replaced by inter crop. In densely sown crop like wheat, particularly under rain fed conditions, inter cropping through replacement series is generally practiced and is viable. Results at various locations indicated that planting geometry plays an important role in optimizing yield levels in inter cropping systems, which may vary with crop combinations, varieties and locations. Growing of crop without any fixed geometry was always inferior than inter cropping with appropriate geometry of planting.

## II. MATERIALS AND METHODS

The field experiment was conducted during rabi seasons for two consecutive years (2013 and 2014) at research farm of Krishi Vigyan Kendra Majhagawan, Satna, Madhya Pradesh. Geographically Satna is situated in the Satpura and Kaymore Plateau range and lies at $24^0$ 51' 15" to $24^0$ 57' 30" N latitude and $80^0$ 43' 30" to $80^0$ 54' 15" E longitude at the elevation of 313 m from mean sea level. The location has subtropical climate characterized by hot dry summer and cool winter. The soil of experimental area was sandy loam in texture and shallow in depth and soil was very low in available nitrogen, low in available phosphorus and higher in available potassium. Soil class was sandy loam and reaction was almost neutral. The mean annual rainfall received during the experimental year varies from 600 mm to 850 mm. The treatments consisted 3 intercropping systems viz. wheat +chick pea, wheat +linseed, wheat +mustard and three row proportions of wheat+ intercrop 2:2, 4:2,6:2 plus one control of sole wheat. Three extra treatments of sole chickpea, sole mustard and sole linseed were also included for comparison. Thus the 10 treatments of wheat based

intercropping were tried in Randomized Block Design with 3 replications. The varieties selected for wheat (HD-2285), chickpea (Uday), linseed (JLS-9) and for mustard (Rohini)The crop was sown on 19 November 2013 and 14 November 2014. The seed rate of intercrops was decided according to row proportions. Weeding was done to conserve soil moisture through dust mulch created by hand weeding after one month of sowing during both years. Thinning operation was adopted in linseed and mustard crop. The crop was harvested on 22.03.2013 and 20.03.2014.

## III. RESULTS AND DISCUSSION

**Growth and yield parameters**

Growth and yield parameters viz. plant height, dry matter accumulation, grains/spike and grain and straw yield of main crop-wheat was found to be significant under intercropping treatments.(Table-1) Singh and Turkhade (1989) and Singh *et al* (1995), respectively**.** Pod/capsule/ siliquae /plant observed significantly highest in all the crops under all the row ratio and same was the case of yield and stover of all the crops in each row ratio. The grain and straw yield per unit area were obtained significantly higher in sole crop of wheat than in intercropping system (Table-1). These higher yields are attributed mainly to higher production of wheat in sole stand than in intercropping, as the intercropping was followed in replacement series. Higher yields of wheat per unit are in sole crop than in intercropping system have also been reported by various workers like Sharma *et al* (1987).

As regards row ratio of wheat +intercrops could not affect the growth contributing characteristic viz. Plant height, dry matter accumulation and leaf area index but grain and straw yield significantly influenced by row ratio. (Table-1) Tomar *et al* (1997) and Hiremath *et al* (1991). Plant height of chickpea was found to be significant and recorded maximum under 2:2 row ratio but less then sole crop of chickpea .whereas 4:2 row ratio gave highest yield with linseed. Dry matter accumulation increased with each wider row ratio (6:2) and produced significantly higher over sole crop of chickpea and mustard but non significant in case of linseed. wheat +intercrops 6:2 row ratio produced significantly highest wheat yields, while 2:2 row ratio produced significantly lowest yields. These yields are attributed directly to plant population of wheat under different row ratios. Similar results have been reported by Hosmani *et al* (1995), and Mandal *et al* (1996)

Interaction effect of row proportions and intercropping was found to be significant in case of dry matter accumulation(g)/10 cm row length under wheat +linseed intercropping with 4:2 row ratio (Table-2). Whereas leaf area index of wheat was found to be maximum at 60 DAS under wheat+chickpea with 2:2 row ratio(Table-3). However grain and straw yield was recorded maximum under wheat +linseed with 4:2 row proportion. (Table-4) It may be supported by the work of Willey (1979) who reported that maximizing intercropping advantages is a matter of maximizing the degree of complimentarity between the component crops.

**Wheat equivalent yield**

Wheat equivalent yield was also computed significantly highest under the treatments of wheat+chickpea (46.04 q/ha) intercropping than sole wheat (39.94 q/ha) and other intercropping treatments (sole chickpea 27.62 q/ha, sole linseed 26.82 q/ha and sole mustard 25.40 q/ha) (table-6). These are attributed to higher yield of both component crops because of better compatibility for resource utilization. These results confirm the findings of Singh *et al* (1992), Wheat equivalent yield increased with each wider row ratio in wheat, linseed or mustard intercropping but reduced in wheat +chickpea intercropping numerically. These findings are in collaboration with Mallik *et al* (1993),

Land equivalent ratio was recorded higher in intercropping treatments of wheat+chickpea as compared to other intercropping and sole cropping treatments (table-6).All intercropping treatments attained higher values of LER than sole crops but recorded maximum (1.36) in wheat+chickpea with 2:2 row ratio. Higher LER in intercropping system in general and in wheat +pulses in particular has also been reported by Singh *et al* (1992). Barik *et al* (2006) reported that land equivalent yield increased with each wider row ratio in wheat, linseed or mustard intercropping but reduced in wheat +chickpea and wheat + mustard intercropping numerically.

**Monetary Return**

Net income and benefit: cost ratio was computed significantly higher in the intercropping treatments of wheat +chickpea than all other treatments (table-6). Net return and benefit: cost ration under wheat +chickpea with 2:2 row ratio was recorded Rs. 42429/ha and 3.64 in comparison of sole wheat, sole chickpea, sole linseed and sole mustard Rs.36882 and 3.45, Rs.19146 and 1.71, Rs.19366 and 2.09, Rs.19589 and 2.15, respectively. These results may very well supported by the findings Singh *et al* (1992.The intercropping treatment of wheat +chickpea being at par with wheat +linseed in 6:2 row ratio and with sole wheat, attained higher values of B:C ratios than all other treatments ( table 3). These are attributed to higher net income in wheat +chickpea

intercroppings and to combined effects of lower cost and higher income in case of wheat +linseed in 6:2 row ratio and sole wheat treatments. Findings of Singh et al (1992) and Srivastav and Bohra (2006) are in agreement to the results of present investigation.

**Table -1** Growth and yield of wheat (q/ha) under different treatments (Pooled data for 2 years)

| Treatment | Plant height (cm) | Dry matter accumulation/10 cm row | No. of grains/spike | Grain yield (q/ha) | Straw yield (q/ha) |
|---|---|---|---|---|---|
| **Intercropping** | | | | | |
| Wheat+chickpea | 98.39 | 31.73 | 36.19 | 32.58 | 45.24 |
| Wheat+linseed | 94.74 | 28.96 | 33.64 | 28.36 | 40.05 |
| Wheat+mustard | 96.85 | 25.11 | 31.77 | 23.07 | 34.95 |
| S.Ed.+- | 0.75 | 0.27 | 0.79 | 0.71 | 0.97 |
| C.D.(P=0.05) | 1.52 | 1.55 | 1.58 | 1.44 | 1.97 |
| Row ratios | | | | | |
| 2:2 | 95.76 | 29.07 | 34.11 | 21.89 | 33.76 |
| 4:2 | 96.80 | 28.93 | 33.90 | 29.19 | 41.80 |
| 6:2 | 97.42 | 27.81 | 33.59 | 32.93 | 44.69 |
| S.Ed.+- | 0.75 | 0.27 | 0.79 | 0.71 | 0.97 |
| C.D.(P=0.05) | NS | NS | NS | 1.44 | 1.97 |
| Sole v/s intercropping | | | | | |
| Sole crop | 99.64 | 25.77 | 32.96 | 39.94 | 50.95 |
| Intercrop wheat | 96.66 | 28.6 | 33.87 | 28 | 40.08 |
| S.Ed.+- | 0.97 | 0.74 | 1.01 | 0.92 | 1.26 |
| C.D.(P=0.05) | 1.96 | 1.49 | NS | 1.86 | 2.54 |

**Table-2** Dry matter accumulation of wheat /10 cm row (g) under interaction effect of intercropping X row ratios (Pooled data for 2 years)

| **Intercroppings** | **Row ratio** | | |
|---|---|---|---|
| | 2:2 | 4:2 | 6:2 |
| Wheat+chickpea | 33.94 | 31.88 | 29.38 |
| Wheat+linseed | 29.52 | 29.34 | 28.03 |
| Wheat+mustard | 23.76 | 25.56 | 26.01 |
| S.Ed.+- | | 0.99 | |
| C.D.(P=0.05) | | 1.99 | |

**Table-3** Leaf area index of wheat at 60 days after sowing under intercropping x row ratio interaction (Pooled)

| **Intercroppings** | **Row ratios** | | | **S.Ed.+-** | **C.D.(P=0.05)** |
|---|---|---|---|---|---|
| | **2:2** | **4:2** | **6:2** | | |
| Wheat+chickpea | 4.22 | 3.5 | 3.48 | 0.09 | 0.19 |
| Wheat+linseed | 3.48 | 3.43 | 3.62 | | |
| Wheat+mustard | 3.24 | 3.3 | 3.43 | | |

**Table-4** Grain and straw yield of wheat (q/ha) under interaction effect of intercropping x row ratio interactions (Pooled)

| **Intercroppings** | **Row ratios** | | | **S.Ed.+-** | **C.D.(P=0.05)** |
|---|---|---|---|---|---|
| | 2:2 | 4:2 | 6:2 | | |
| Wheat+chickpea (grain) | 28.3 | 33.69 | 35.75 | | |
| Wheat+chickpea(Straw) | 42.33 | 46.50 | 46.90 | - | - |
| Wheat+linseed (grain) | 21.22 | 29.63 | 34.24 | 1.24 | 2.5 |
| Wheat+linseed (Straw) | 33.06 | 42.02 | 45.07 | 1.69 | 3.40 |
| Wheat+mustard (grain) | 16.16 | 24.25 | 28.79 | | |
| Wheat+mustard (Straw) | 25.88 | 36.88 | 42.11 | - | - |

**Table- 5** Growth and yield of intercrops under different treatments (Pooled data for 2 years)

| | Treatments | | | | S.Ed.+- | C.D.(P=0.05) |
|---|---|---|---|---|---|---|
| | Plant height (cm) | | | | | |
| Crop | Sole crop | 2:2 | 4:2 | 6:2 | | |
| Chickpea | 42.67 | 40.72 | 40.32 | 40.08 | 0.66 | 1.43 |
| Linseed | 48.66 | 45.53 | 46.23 | 46.38 | 1.07 | 2.32 |
| Mustard | 146.12 | 142.11 | 142.57 | 143.5 | 2.05 | NS |
| | Dry matter accumulation (g)/10 cm row | | | | | |
| Chickpea | 16 | 19.5 | 19.67 | 19.64 | 0.49 | 1.07 |
| Linseed | 3.053 | 2.984 | 2.892 | 2.891 | 0.081 | NS |
| Mustard | 16.05 | 21.24 | 21.05 | 21.05 | 0.42 | 0.91 |
| | Pod/capsule/ siliquae /plant | | | | | |
| Chickpea | 22.67 | 26.22 | 27.1 | 26.94 | 0.82 | 1.79 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Linseed | 28.27 | 31.13 | 30.39 | 29.94 | 0.83 | 1.8 |
| Mustard | 115.77 | 131.78 | 135.65 | 136.51 | 3.72 | 8.11 |
| | Grain yield (q/ha) | | | | | |
| Chickpea | 19.73 | 12.67 | 8.52 | 6.56 | 0.56 | 1.22 |
| Linseed | 12.19 | 6.66 | 4.63 | 3.41 | 0.29 | 0.64 |
| Mustard | 14.11 | 10.54 | 7.11 | 5.39 | 0.32 | 0.69 |
| | Straw yield (q/ha) | | | | | |
| Chickpea | 27.26 | 17.1 | 11.38 | 8.83 | 0.65 | 1.41 |
| Linseed | 19.71 | 10.3 | 7.08 | 5.28 | 0.45 | 0.97 |

**Table -6** Wheat equivalent yield (q/ha), land equivalent ratio, net income (000 Rs./ha) and benefit :cost ratio under different treatments (Pooled data for 2 years)

| Treatments | Wheat equivalent yield(q/ha) | Land equivalent ratio | Net income (000 Rs/ha) | B:C ratio |
|---|---|---|---|---|
| Sole wheat | 39.94 | 1 | 36.882 | 3.45 |
| Wheat+chickpea(2:2) | 46.04 | 1.36 | 42.429 | 3.64 |
| Wheat+linseed(2:2) | 35.86 | 1.08 | 30.52 | 2.84 |
| Wheat+mustard(2:2) | 35.14 | 1.16 | 30.203 | 2.79 |
| Wheat+chickpea(4:2) | 44.61 | 1.27 | 41.232 | 3.59 |
| Wheat+linseed(4:2) | 39.83 | 1.12 | 35.687 | 3.31 |
| Wheat+mustard(4:2) | 37.04 | 1.11 | 33.119 | 3.06 |
| Wheat+chickpea(6:2) | 44.16 | 1.23 | 40.718 | 3.59 |
| Wheat+linseed(6:2) | 41.76 | 1.14 | 37.952 | 3.5 |
| Wheat+mustard(6:2) | 38.5 | 1.1 | 25.07 | 3.24 |
| S.Ed.+- | 1.92 | 0.06 | 1.914 | 0.17 |
| C.D.(P=0.05) | 3.76 | 0.11 | 3.752 | 0.33 |
| Sole intercrop | | | | |
| Chickpea | 27.62 | 1 | 19.146 | 1.71 |
| Linseed | 26.82 | 1 | 19.366 | 2.09 |
| Mustard | 25.4 | 1 | 19.589 | 2.15 |

## IV. CONCLUSION

Intercropping with wheat +chickpea in 2:2 row ratio recorded significantly higher wheat equivalent yield (WEY) 46.04 q/ha, land equivalent ratio (LER) 1.36,net income Rs.42429/ha and benefit :cost ratio 3.64 in comparison of sloe crop of wheat 39.94 q/ha, 1, Rs.38882/ha and 3.45, sloe crop of chickpea 27.62 q/ha, 1, Rs.19146/ha and 1.71, sloe crop of linseed 26.82 q/ha, 1, Rs.19366/ha and 2.09, sloe crop of mustard 25.40 q/ha, 1, Rs.19589/ha and 2.15,respectively.

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