



Research Article

EFFECT OF TILLAGE PRACTICES, CROPPING SYSTEMS, MULCHING AND FERTILIZER ON GROWTH, YIELD ATTRIBUTES AND YIELD OF MARIGOLD (*Tagetes erecta*) UNDER INTENSIVE CROPPING SYSTEM

PARSHOTAM KUMAR^{1*}, KACHROO D.¹, THAKUR N.P.¹, GUPTA A.K.¹, GAGANPREET KOUR¹, SHARMA R.² AND ARCHANA³

¹Farming System Research Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, 180009, India

²Scientist RHRSS, Bhadarwaha, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, 180009, India

³Division of Statistic, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, 180009, India

*Corresponding Author: Email - gagankour103@gmail.com

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Abstract: A field experiment was conducted at the Research Farm, Main Campus, Chatha of SKUAST-Jammu during the year 2012-13 and 2013-14 to evaluate tillage practices, cropping systems, mulching and fertilizer on growth, yield attributes and yield of marigold (*Tagetes erecta*) under intensive cropping system. The experiment was laid out in split-plot design with two crop establishment methods (Minimum/Zero tillage and conventional tillage) and three cropping systems (Rice-Wheat, Rice-Marigold-French bean and Maize + soyabean -Wheat) and two fertilizer rates (Rec. Dose of Fertilizer and 75% RDF + 25%N through FYM) with and without mulching in sub-plots under clay loam soil having alkaline in reaction (pH-8.1), medium in soil organic carbon, available P & K and low in available N. The results revealed that Rice-Marigold-French bean cropping system, recorded higher REY (223.39 q/ha and 198.48 q/ha), system duration (309, 315 days), system profitability (Rs. 662 /ha/day and 838/ha/day), land use efficiency (85% and 86%) and production efficiency (Rs. 72 and 63 kg/ha/day) during both the years. The maximum net return of Rs. 240372 and Rs. 239015/- was recorded under Rice- Marigold- French bean cropping system with B: C ratio of 2.18 and 2.03. while application of paddy straw as mulch @ 5 ton/ha during Rabi season with INM under conventional method of sowing to Rice-Marigold-French bean has yielded maximum REY of 210.93 q/ha with net returns (Rs 239693) and B:C ratio of 2.10 as compared to non mulch treatment.

Keywords: Marigold, Minimum Tillage, Mulching, Cropping System, Rice Equivalent Yield

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Introduction

Urbanization and rising living standards of the people has leads to steady increase in demand of flowers and flower products making floriculture as one of the most important commercial trades in Jammu and Kashmir State and is practiced over an area of about 0.8 ha area with a production of 0.4 million tons [16]. Floriculture is a lucrative business in India because commercially flower production has higher potential per unit area than most of the field crops. Rice-Wheat cropping system is predominant in sub-tropical and temperate zones of Jammu region [1] have less average yield of both rice and wheat is also less in terms of productivity and profitability and therefore needs to be reversed by diversification of crops inclusion of high value vegetable and floriculture crops which have the potential to increase production and economics due to high cropping intensity through addition of low volume high value crops over existing rice-wheat cropping system. Diversification of existing cropping system is necessary to get higher yield and return to maintain soil health and preserve environment. Crop diversification in areas, where continues cropping of cereals-cereals is in vague have shown marked advantage over existing cropping systems. New cropping systems or crop diversification resulted in enhanced annual productivity ranging between 25 and 117 per cent over the existing cropping systems [2]. Rice-Marigold-French bean is a diversified cropping system which is highly profitable. Marigold being a flower/cash crop has great potential in the city of temples and other uses of flower for various occasions whereas French bean occupies unique position in the state as a vegetable crop. French bean can grow in subtropical as well as intermediate zone of Jammu and Kashmir.

Materials and methods

The field experiment was conducted during Rabi, Kharif and Zaid seasons of 2012-13 and 2013-14 at the Research Farm, FSR, Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha, Jammu located at a latitude of 32°-40' N and longitude of 74°-58' E with an altitude of 332 m above mean sea level. The climate of Jammu is Sub-tropical (Low altitude sub tropical zone of Jammu) with hot and humid rainy season, hot dry summer and warm autumn and cool winter. The maximum temperature during summer rises to about 42°C and minimum temperature during winter fall to 3°C. Average rain fall of the study area is 1150 mm, major portion which is received during the months of July to September. The experiment was laid out in split- plot design with two crop establishment methods (Minimum / Zero tillage and conventional tillage) and three cropping systems (Rice-Wheat, Rice-Marigold-French bean and Maize + soybean -Wheat) in main plot and two fertilizer rates (Rec. Dose of Fertilizer and 75% RDF + 25%N through FYM) with and without mulching in sub-plots making 24 treatment combinations with three replications. The soil of the experimental site was clay loam in texture having alkaline in reaction (pH-8.1), medium in soil organic carbon, available P & K and low in available N. During both the years rice was sown directly with zero till drill at seed rate of 25kg/ha under minimum tillage practice during the month of June and simultaneously rice was sown through dry seeding @ of 40 kg/ha in well pulverized nursery bed for transplanted rice (conventional methods of crop establishment) and 25 days age old seedlings were transplanted in the field at experimentation site having plot size of 12mx5m.

Table-1 Periodical Plant height of marigold as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates

Treatment	Plant height (cm)									
	20 Days		40 Days		60 Days		80 Days		100 Days	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Crop Establishment Methods										
Minimum Tillage	18.50	17.39	31.23	31.22	53.75	53.21	63.90	63.85	65.80	65.09
Conventional Tillage	21.73	21.51	36.00	34.38	60.58	57.80	67.75	66.28	70.00	67.58
Cropping System										
Rice-Wheat	-	-	-	-	-	-	-	-	-	-
Rice-Marigold-Frenchbean	20.11	19.95	33.61	32.81	57.16	55.50	65.83	65.06	67.90	66.34
Maize + soybean-Wheat	-	-	-	-	-	-	-	-	-	-
Mulching										
No Mulch	18.95	18.58	32.88	31.78	55.55	54.08	64.20	63.75	65.98	65.17
Mulch with rice straw	21.28	21.32	34.35	33.84	58.78	56.93	67.45	66.38	69.83	67.51
Fertilizer Rates										
100% RDF	19.93	19.64	33.30	32.42	56.80	55.29	65.10	64.64	67.10	65.90
75%RDF+25% N through FYM	20.30	20.26	33.93	33.20	57.53	55.72	66.55	65.48	68.70	66.78

Table-2 Periodical dry matter of marigold as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates

Treatment	Dry matter (g/m ²)									
	20 Days		40 Days		60 Days		80 Days		100 Days	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Crop Establishment Methods										
Minimum Tillage	6.85	5.45	32.08	28.95	144.25	132.50	282.75	266.00	287.25	273.50
Conventional Tillage	8.53	7.20	38.05	36.50	179.00	159.25	333.75	303.25	346.75	311.75
Cropping System										
Rice-Wheat										
Rice-Marigold-Frenchbean	7.69	6.33	35.06	32.73	161.63	145.88	308.25	284.63	317.00	292.63
Maize+soybean-Wheat										
Mulching										
No Mulch	7.20	5.80	32.95	30.70	151.25	137.50	293.25	273.00	302.00	281.25
Mulch with rice straw	8.18	6.85	37.18	34.75	172.00	154.25	323.25	296.25	332.00	304.00
Fertilizer Rates										
100% RDF	7.43	6.23	34.13	31.50	156.50	142.75	301.75	279.00	310.00	286.25
75%RDF+25% N through FYM	7.95	6.43	36.00	33.95	166.75	149.00	314.75	290.25	324.00	299.00

Table-3 Number of flowers/plant and Yield of marigold as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates

Treatment	No. of flowers/plant		Average fresh weight of flower (g)		Yield(kg/ha)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Crop Establishment Methods						
Minimum Tillage	23.00	20.88	4.95	4.10	7291.00	6166.75
Conventional Tillage	27.25	24.48	6.14	5.90	8043.25	7035.50
Cropping System						
Rice-Wheat						
Rice-Marigold-Frenchbean	25.13	22.68	5.54	5.23	7667.13	6601.13
Maize+soybean-Wheat						
Mulching						
No Mulch	24.05	21.55	5.31	5.11	7520.00	6387.50
Mulch with rice straw	26.20	23.80	5.79	5.53	7814.25	6814.75
Fertilizer Rates						
100% RDF	24.75	22.30	5.42	5.32	7559.75	6510.50
75%RDF+25% N through FYM	25.50	23.05	5.67	5.43	7774.50	6691.75

Table-4 Economics of marigold as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates

Treatment	Gross returns (Rs/ha)		Cost of cultivation (Rs/ha)		Net returns (Rs/ha)		B:C Ratio	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Crop Establishment Methods								
Minimum Tillage	145820.00	154168.75	38905.50	42900.50	106914.50	111268.25	2.82	2.65
Conventional Tillage	160865.00	175887.50	40405.50	44401.50	120459.50	131486.00	3.06	3.02
Cropping System								
Rice-Wheat	-	-	-	-	-	-	-	-
Rice-Marigold-Frenchbean	153342.50	165028.13	39655.50	43651.00	113687.00	121377.13	2.94	2.83
Maize+soybean-Wheat	-	-	-	-	-	-	-	-
Mulching								
No Mulch	150400.00	159687.50	37155.50	41151.00	113244.50	118536.50	3.12	2.94
Mulch with rice straw	156285.00	170368.75	42155.50	46151.00	114129.50	124217.75	2.76	2.73
Fertilizer Rates								
100% RDF	151195.00	162762.50	34292.00	38288.00	116903.00	124474.50	3.42	3.26
75%RDF+25% N through FYM	155490.00	167293.75	45019.00	49014.00	110471.00	118279.75	2.46	2.41

Table-5 Rice Equivalent yield and resource use efficiency as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates

Treatment	REY(kg/ha)		Production Efficiency (Kg/ha/day)		System Duration (days)		System Profitability (Rs/ha/day)		Land Use Efficiency (%)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Crop Establishment Methods										
Minimum Tillage	12848	11581	44	42	283	288	344	389	77	79
Conventional Tillage	14395	12916	48	47	289	294	389	445	79	81
SEM ±	37.3	61.9								
LSD (P=0.05)	113.3	188								
Cropping System										
Rice-Wheat	8339	7509	31	27	273	278	191	186	75	76
Rice-Marigold-Frenchbean	22339	19848	72	25	309	315	662	838	85	86
Maize+ Soybean-Wheat	10187	9389	36	31	276	280	247	226	76	77
SEM ±	45.7	75.9								
LSD (P=0.05)	138.7	230								
Mulching										
No Mulch	13237	11848	45	43	286	291	359	404	78	80
Mulch with rice straw	14006	12649	48	46	286	291	374	429	78	80
SEM ±	37.5	33.1								
LSD (P=0.05)	106.8	94								
Fertilizer Rates										
100% RDF	13386	12016	46	44	286	291	376	426	78	80
75%RDF+25% N through FYM	13855	12481	47	45	286	291	356	407	78	80
SEM ±	37.5	33.1								
LSD (P=0.05)	106.8	94								

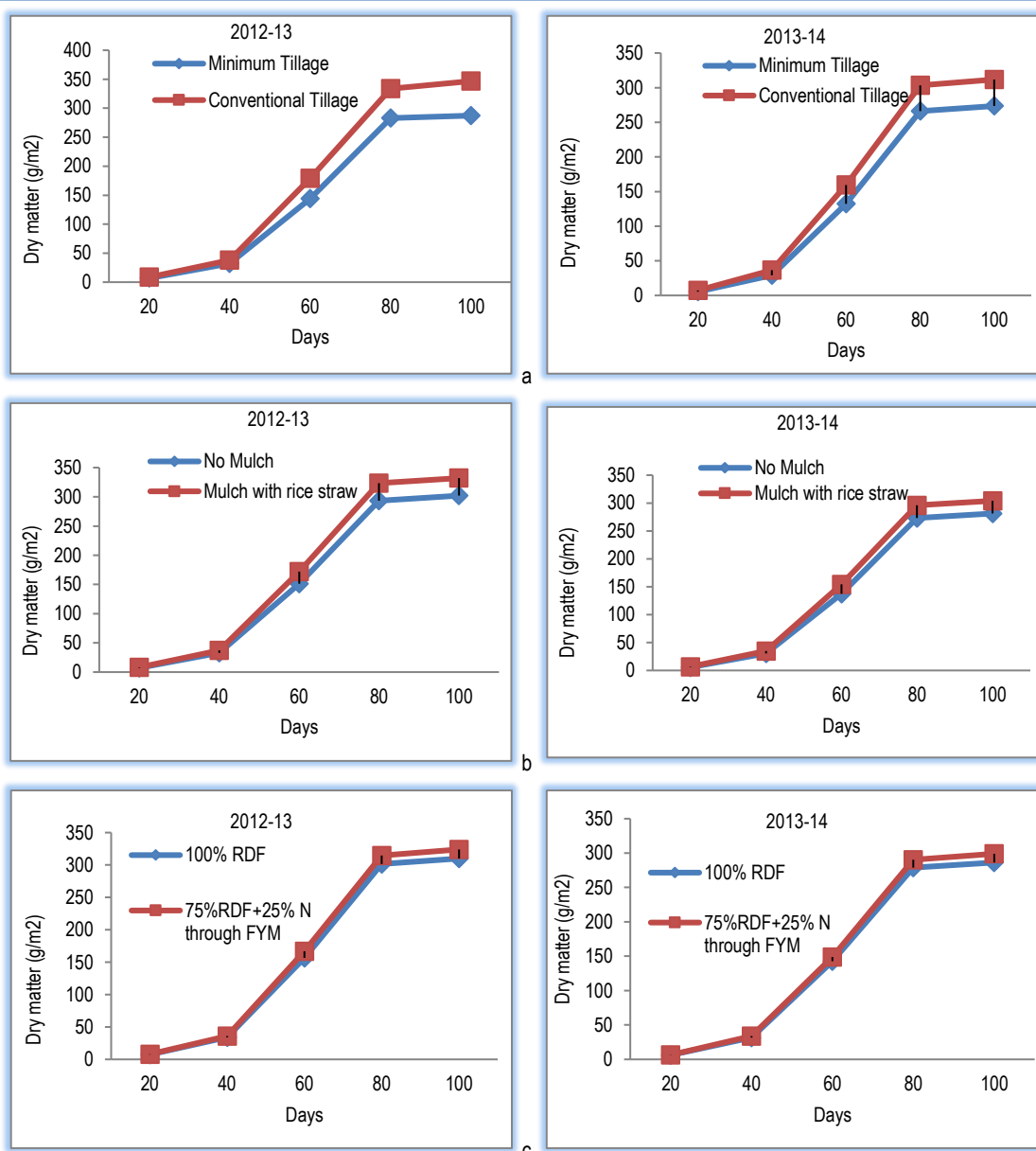


Fig-1 Dry matter of marigold as influenced by crop establishment methods, mulching and fertilizer rates, (a) crop establishment methods vs dry matter, (b) mulching vs dry matter and (c) fertilizer rates vs dry matter

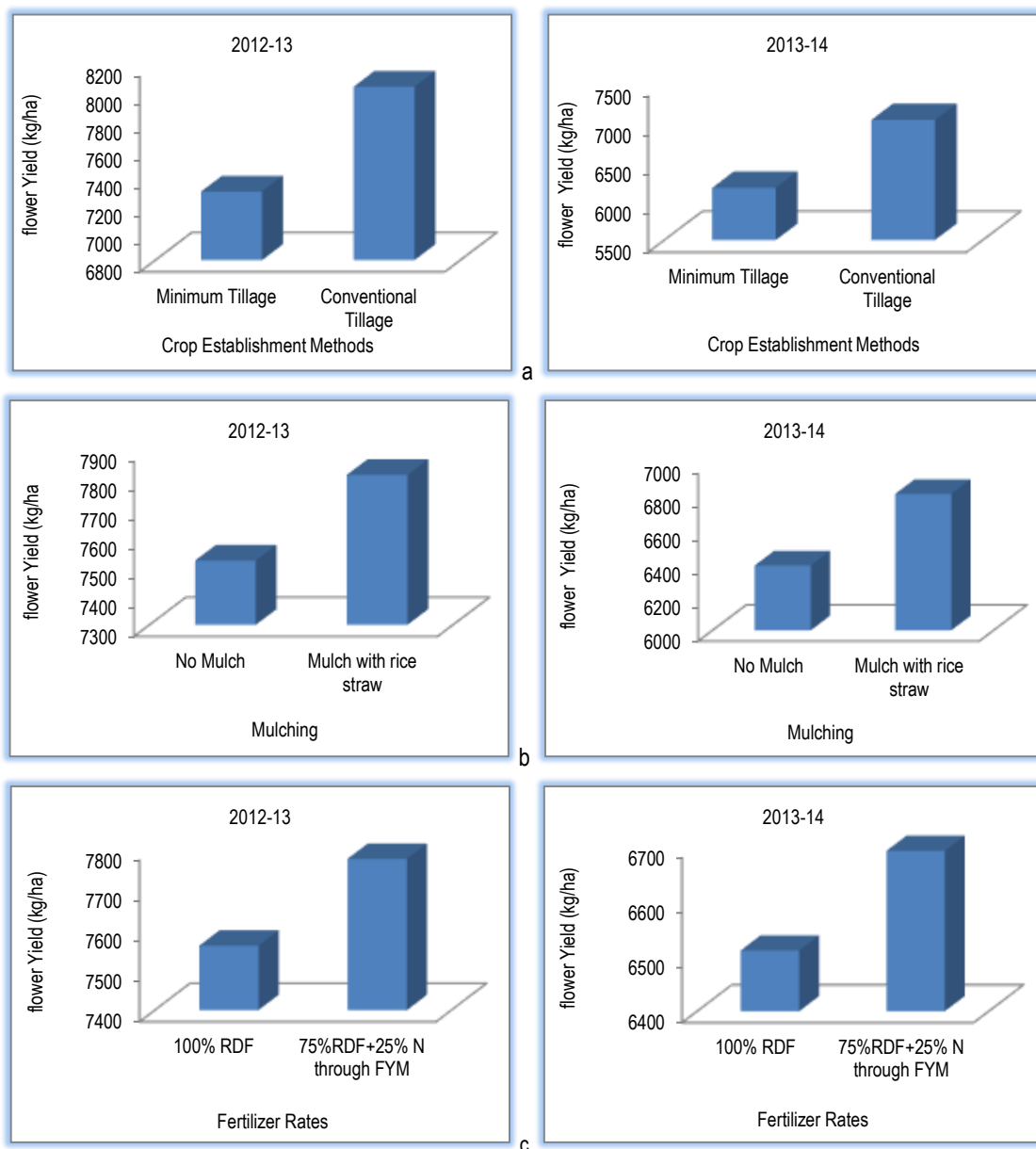


Fig-2 Flower yield of marigold as influenced by crop establishment methods, cropping systems, mulching and fertilizer rates, (a) crop establishment methods vs yield, (b) mulching vs yield and (c) fertilizer rates vs yield.

The plots were prepared in such a way in both season to avoid any transportation of soil from one plot to another. For keeping the weed flora below the thresh hold value pendimethalin @ 1kg/ha as pre-emergence was applied just after the sowing of direct seeded rice followed by bispyribac sodium @ .025kg/ha, as post-emergence after 25 days of sowing followed by one a hand weeding at 60 DAS. In conventional method of crop establishment, field was first ploughed by the tractor driven tiller, then the soil was puddle with puddler and the transplanting of single seedling per hill was done. Machette granular 5% a.i @30 kg /ha was applied just after transplanting of rice. Application of 25% N through FYM (as per treatment) was given 15 days before sowing/transplanting the crop and half dose of Nitrogen(50 Kg/ha) as basal and full dose of P&K (30kg/ha and 20 kg/ha) was applied at the time of sowing. Short duration variety IET-1410(120 days maturity period from seed to seed) was used at a spacing of 20 × 15 cm in the plots where the crop established through transplanting method, whereas the crop sown under direct seeding through zero tillage seed drill did not observe any specific plant to plant distant. However, plant population was maintained by applying seed rate 25kg/ha but the line to line distance of 20 cm was maintained. Water management was done by irrigating the field as the hair like cracks on the top soil crust appeared in direct seeded rice, whereas the irrigation was applied through flooded method. Harvesting was done manually with the help of sickle from net plot area

(10m x 4m) and manually threshed grain and straw yield was recorded as per treatment. Hybrid maize crop (variety- double Monsanto) was also raised during *kharif* season i.e., third week of June during both the years. The field was prepared with tiller followed by rotavator under conventional method of sowing and seeds were directly sown with line marker under both the methods of sowing (minimum/zero tillage and conventional tillage) using seed rate of 20kg/ha having spacing of 60 x 20 cm. whereas, Soybean crop was taken as inter crop, an additive series (1:1) with a seed rate of 20kg/ha. Half dose of N and full dose of P&K was applied as basal dose at the time of sowing and rest dose in splits at knee-high and tesselling stage. Weeding was done manually with the help of khurpi at 20 and 40 DAS and earthing was done manually at knee high stage 25 DAS. Crop was harvested manually from net plot area (9.60m x 4m) and threshed grain and straw yield was recorded plot-wise. During *rabi* season, the wheat variety PBW 557 was sown in the month of November using seed drill @ 100 kg seed/ha for crop established under conventional practice whereas under minimum tillage, zero till drill was used with same seed rate. and marigold (*Pusa Narangi*) crop was raised in nursery in September @ 1 kg seed/ha and later transplanted in the month of October at the experimental site at distance of 50X40cm. Weedicide clodinafopropogyl @ 0.06kg/ha was applied 30 DAS followed by 2,4-D @ 0.5kg/ha at 35 DAS.

Fertilizers through FYM and in-organics as per treatment were applied at the time of sowing. Application of FYM and N, P & K (100:50:25) was applied as per treatment. Mulching with rice straw @ 5ton/ha was spread manually between the rows of wheat crop which covered 60-90 % area between rows. Harvesting was done manually from net plot area (10m X 4m) and threshed by using tractor-operated thresher and yield was recorded as per treatment. In case of marigold crop field, the nipping of buds was done manually after 25 DAT, whereas the mulching at 10 DAT with rice straw spread in between the rows in treatments where mulching as treatment was done. For effective weed control, mechanical weeding with khurpi was done at 20 DAT. Harvesting, by plucking the flowers manually and weight of flowers per net plot area (10mX4m) was recorded as per treatment. In summer season, frenchbean crop (variety-Contender) with a seed rate of 80kg/ha at spacing of 60X10 cm was sown manually with line marker under minimum tillage practice and conventional method of sowing. The harvesting was done by picking fresh green pods from net plot area (9.60m X 4m) in 5 pickings. Before starting the experiment, a composite soil sample (0-15 cm) was collected from the experimental site. At the end of cropping cycle, post harvest soil sample (0-15 cm) were collected and analyzed for physical and chemical properties. Statistical analysis of all the data was done as per the methodology of Gomez and Gomez (1984). The rice equivalent yield was calculated by using the following formula:

$$REY = \frac{\sum Y_i \times P_i}{P(p)}$$

Where REY: denotes rice equivalent yield

Y_i = yield of different crops

P_i = price of respective crops

P (p) = price of paddy

Result and discussion

Growth

The growth of marigold crop measured in terms of plant height (cm) and dry matter accumulation (g/m²) was comparatively higher during 1st year of experimentation [Table-1] & [Table-2]. This was mainly attributed to favorable climatic conditions as compared to 2nd year of experimentation. Under crop establishment method, conventional tillage practice produces taller plants (cm) and higher dry matter accumulation (g/m²) as compared to minimum tillage [Fig-1] which might be due to favorable crop growth condition provided by better pulverization of soil that increase nutrient availability and decreased weed-competition for nutrients. Mulching with rice straw @ 5ton/ha to marigold crop also produced higher plant height and higher dry matter accumulation, which might be due to better effect of mulching during *rabi* season as it regulates the temperature and improves soil properties. Application of 75% RDF + 25% N through FYM showed an increasing trend in terms of plant height, dry matter accumulation over 100 % RDF which might be due to slow release of nutrient supplied through FYM in combination with in organic fertilizers. These results are in conformity with the findings of [5, 9, 11 & 12].

Yield attributes and yields of marigold

Yield is resultant of yield attributes viz., number of fresh flowers/plant, average fresh flower weight. The number of fresh flowers/plant, average fresh flower weight and flower yield was observed higher during both the years, probably due to better environmental conditions [Table-3]. Under crop establishment methods, higher number of fresh flowers/plant, average fresh flower weight and flower yield was observed in conventional tillage as compared to minimum tillage [Fig-2], which might be due to favorable crop growth condition provided by better pulverization of soil that increase nutrient availability and decreased weed-competition for nutrients. Mulching with rice straw @5ton/ha, also recorded higher yield attributes and yield of marigold crop. Mulching maintain soil cover, conserve soil moisture, control temperature, suppress weeds and increase in population of micro flora thereby augment the crop yield [6]. Also mulching has favorable effect on soil physical, chemical and biological properties such as pH, organic carbon and water holding capacity and bulk density of soil [3, 4, 8 & 15]. Application of 75% RDF + 25% N through FYM recorded higher no. of fresh flower/plant and

average fresh flower weight over 100 RDF. Organic sources of nutrient acts as slow release fertilizers as it synchronizes the nutrient demand of plant [7, 9, & 12].

Economic studies

Cost of cultivation, gross returns and net returns were registered lesser but B: C ratio was higher during 1st year of experimentation than 2nd year of experimentation [Table-4] which was probably due to higher labour cost during 2nd year of experimentation. Under crop establishment method, conventional tillage recorded higher cost of cultivation, gross returns, net returns and B: C ratio, owing to higher yield attributing characters and yield, which might be due to better availability of nutrient in conventional tillage as compared to minimum tillage. Minimum tillage is subjected to greater weed competition that might reduce the yield. Mulching with rice straw @5ton/ha, also registered higher cost of cultivation owing to higher cost of rice straw, higher gross returns, owing to higher yield but lower net returns and B:C ratio as compared to no mulched treatments, which might be due to low cost of cultivation under no mulching. Application of 75% RDF + 25% N through FYM registered higher cost of cultivation, gross returns, but lower net returns and B: C ratio, which was probably due to lesser cost of cultivation under 100% RDF. These results are in confirmation with [14] & [18]. Rice Equivalent Yield (kg/ha) and Resource use efficiency (%) Under crop establishment methods, conventional tillage recorded significantly higher rice equivalent yield than the minimum tillage which works out to be 12.04 per cent and 17.5 per cent higher during 2012-13 and 2013-14, respectively [Table-5]. Lower economic yields under minimum tillage which may be due to poor crop establishment due to higher microbial resistance to soil and crop weed competition [10], while production efficiency (kg/ha/day), system duration (days), system profitability (Rs/ha/day) and land use efficiency (%) were also recorded higher under conventional tillage practice. Under various cropping system treatments, rice-marigold French bean produced significant higher REY followed by maize + soya bean-wheat over existing rice-wheat cropping system during both years, respectively. Rice-garlic-cowpea recorded the highest average REY followed by rice-potato-onion and rice-marigold-frenchbean than rice-wheat system [13]. Involving legume as intercrop in maize crop increased the maize equivalent yield. Whereas, production efficiency (kg/ha/day), system duration (days), system profitability (Rs/ha/day) and land use efficiency (%) were also recorded higher under rice-marigold-frenchbean cropping system followed by maize + soybean-wheat cropping system over existing rice-wheat system. Rice equivalent yield (REY), during both the years, under cover with rice mulch (more than 66% land cover) during *rabi* season produced significantly higher values of REY. Significantly higher paddy equivalent yield was recorded in mulching over no mulch [17]. Production efficiency (kg/ha/day) and system profitability (Rs/ha/day) were also found higher in mulching over no mulch. However, between the fertilizer application, 75% recommended dose of fertilizer coupled with 25% N through FYM to each crop in a cycle during both the years of experimentation resulted significantly higher REY, production efficiency (kg/ha/day) and system profitability (Rs/ha/day) over 100% recommended dose of fertilizer application owing to higher crop yields. Whereas system duration and land use efficiency were not affected by mulching and fertilizer rates.

Conclusion

From this study, it may be concluded that after completion of two years, inclusion of marigold as a loose flower in *rabi* and French bean as a table purpose in summer in a rice-marigold-french bean system was found beneficial for getting higher remunerative by adopting conventional tillage with combination of mulching of paddy @ 5 ton/ha and 75% RDF + 25% N through FYM in clay loam soil in sub tropical conditions of Jammu.

Application of research: Research is useful for the farmer community.

Research Category: Resource conservation and diversification

Abbreviations:

RDF: Recommended dose of fertilizer

FYM: farmyard manure
REY: rice equivalent yield
Rs: rupees
ha: hectares
kg: kilogram

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***Principle Investigator or Chairperson of research: Dr Dileep Kachroo**

University: Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, 180009, India
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Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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