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Nutrient Capture Efficiency, Use Efficiency and Productivity in Sole Cropping and Intercropping of Rapeseed, Bean and Corn

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INTRODUCTION

- Nutrients are the second most important limiting factor after water in crop production.
- Nitrogen, phosphorus and potassium are the most required nutrients in crop production.
- Increasing nutrient efficiency causes reduction in environmental pollution and economic incomes improving for farmers.
- Root system is extensive in intercropping and it is possible to uptake immobile nutrients like phosphorous and potassium from larger area. (There are some reports on increasing in average of nutrients uptake in intercropping compared to sole cropping).
- Legumes in intercropping with grass provide large amount of needed nitrogen.

OUR GOALS

"Examining of intercropping and sole cropping of three crops including rapeseed, bean and corn with a view to investigation of nutrient efficiency in terms of capture and use efficiency and also productivity for the main plant nutrients as nitrogen, phosphorus and potassium".
(With consideration to ecological and agronomic importance of intercropping systems).

MATERIALS AND METHODS

Crops:
- Rapeseed (*Brassica napus* L.)
- Bean (*Phaseolus vulgaris* L.)
- Corn (*Zea mays* L.)

Test Time: Two growing seasons of 2007-2008 and 2008-2009
Test Place: Research Farm of Faculty of Agriculture, Mashhad, Iran
Experimental Design: Randomized Complete Block Design
Number of: Replications (3) & Treatments (6)
Treatments Types:

Sole cropping:
1- Sole rapeseed (sown 23 September)
2- Sole bean (sown in 30 April)
3- Sole corn (sown in 30 April)

Intercropping:
4- Simultaneous intercropping of bean and corn (sown in 30 April)
5- Two-stage relay intercropping (rapeseed sown in 23 September and bean and corn in 30 April)
6- Three-stage relay intercropping (rapeseed sown in 23 September, bean sown in 9 April and corn sown in 30 April)

Measuring:
- Nitrogen: By standard methods of Kejeldal
- Phosphorus: By spectrophotometer instruments
- Potassium: By flame photometer instruments

Calculations:
Calculation of capture efficiency, use efficiency and productivity (based on total dry matter and seed yield) (*Caviglia etal., 2004*) for each species and land equivalent ratio based on seed yield & total dry matter

RESULTS AND DISCUSSION

Table: Nutrient economy and yield characteristics for sole and intercropping of rapeseed (*Brassica napus*), bean (*Phaseolus vulgaris*) and corn (*Zea mays*); (Mean of two years of 2007-2008 & 2008-2009)

Trait	Units	Sole cropping			Simultaneous intercropping		Two-stage relay intercropping			Three-stage relay intercropping		
		Rapeseed	Bean	Corn	Bean	Corn	Rapeseed	Bean	Corn	Rapeseed	Bean	Corn
N concentration in total dry matter	g.kg^{-1}	12.7	21.0	9.9	18.5	7.2	6.5	18.0	7.5	6.5	18.0	7.5
Nitrogen capture (DM)	Kg.ha^{-1}	115.9	70.4	177.2	60.7	120.2	55.1	37.6	52.5	57.9	30.3	57.0
Nitrogen capture efficiency	%	31 a*	26 a	53 a	21 ab	47 a	15 b	11 bc	16 b	15 b	9 c	18 b
Nitrogen use efficiency (DM)	Kg.kg^{-1}	81.0 b	47.7 b	100.9 c	54.4 a	144.2 a	154.8 a	56.25 a	133.9 b	155.2 a	56.3 a	134.5 b
Nitrogen use efficiency (SY)	Kg.kg^{-1}	18.3 b	17.2 a	28.8 c	20.2 a	43.4 a	25.8 a	18.4 a	37.6 b	24.2 a	16.9 a	36.4 b
Nitrogen productivity (DM)	Kg.kg^{-1}	25.1 a	12.4 a	53.5 a	11.4 a	67.8 a	23.2 a	6.2 a	21.4 b	23.3 a	5.1 a	24.2 b
Nitrogen productivity (SY)	Kg.kg^{-1}	5.7 a	4.5 a	15.2 b	4.3 ab	20.4 a	3.9 a	2.0 bc	6.0 c	3.6 a	1.5 c	6.6 c
P concentration in total dry matter	g.kg^{-1}	1.6	3.0	1.0	2.9	1.0	0.9	1.5	1.2	0.8	1.5	1
Total Phosphorus capture (DM)	Kg.ha^{-1}	13.1	10.4	17.8	9.4	16.3	7.3	3.3	8.6	7.6	2.6	7.5
Phosphorus capture efficiency	%	20.0 a	16.0 a	27.0 a	14.0 a	24.0 a	11.0 b	5.0 b	13.0 b	11.0 b	4.0 b	11.0 b
Phosphorus use efficiency (DM)	Kg.kg^{-1}	732.0 b	375.0 b	1002.0 a	402.8 b	1003.0 a	1163.0 a	751.7 a	916.7 a	1181.0 a	750.0 a	1000.0 a
Phosphorus use efficiency (SY)	Kg.kg^{-1}	158.1 a	140.5 b	285.5 a	152.1 b	299.4 a	192.7 a	255.8 a	255.8 a	184.1 a	232.3 a	270.0 a
Phosphorus productivity (DM)	Kg.kg^{-1}	146.4 a	60.0 a	270.5 a	56.4a	240.7 a	127.9 a	37.6 a	119.2 b	129.9 a	30.0 a	110.0 b
Phosphorus productivity (SY)	Kg.kg^{-1}	31.6 a	22.5 a	77.1 a	21.3 a	71.9 a	21.2 b	12.8 ab	33.2 b	20.2 b	9.3 b	29.7 b
K concentration in total dry matter	g.kg^{-1}	13.5	30.0	9.0	25.0	7.5	5.3	20.0	5.0	5. 7	25.0	4.5
Total Potassium capture (DM)	Kg.ha^{-1}	122.4	101.0	160.5	81.6	126.1	45.2	42.2	34.7	51.8	42.9	34.9
Potassium Capture Efficiency	%	32.0 a	27.0 a	44.0 a	22.0 ab	35.0 a	12.0 b	11.0 b	9.0 b	13.0 b	12.0 b	10.0 b
Potassium use efficiency (DM)	Kg.kg^{-1}	79.9 b	33.3 a	111.1 d	40.0 a	150.0 c	190.5 a	50.0 a	200.0 b	181.0 a	41. 7 a	225.0 a
Potassium use efficiency (SY)	Kg.kg^{-1}	17.6 b	12.1 a	31.7 c	14.9 a	45.5 b	31.1 a	16.5 a	56.0 a	28.5 a	12.8 a	61.2 a
Potassium productivity (DM)	Kg.kg^{-1}	25.6 a	9.0 a	48.9 a	8.8 a	52.5 a	22.9 a	5.5 a	18.0 b	23.5 a	5.0 a	22.5 b
Potassium productivity (SY)	Kg.kg^{-1}	5.6 a	3.3 a	13.9 a	3.3 a	15.9 a	3.7 b	1.8 ab	5.0 b	3.7 b	1.5 b	6.1 b
Total dry matter (TDM)	Kg.ha^{-1}	9305 a	3162 a	17835 a	3265 a	16350 a	8475 a	2115 b	6945 b	8750 a	1695 b	7490 b
Seed yield	Kg.ha^{-1}	2020 a	1195 a	5000 a	1140 a	4835 a	1405 b	700 b	1950 b	1335 b	490 b	1965 b
Harvest index	kg seed. kg^{-1} TDM	0.23 a	0.38 a	0.29 a	0.35 a	0.30 a	0.17 b	0.33 a	0.28 a	0.16 b	0.29 a	0.27 a

DM: based on total dry matter; SY: based on seed yield
*: Means by the uncommon letter in each row (for each species) are significantly different according to Duncan's Multiple Range Tests (p≤0.01).
Orange, Brown & Yellow show superiority of Rapeseed, Bean & Corn in treatments, respectively.

CONCLUSION

In some cases, intercropping combinations showed positive and significant (P≤0.01) effects on nutrients capture efficiency, use efficiency and productivity compared with sole cropping treatments.

LER values for seed yield and total dry matter were higher than 1 for intercropping combinations.

Generally, among intercropping combinations, simultaneous intercropping of bean and corn can improve productivity index.

REFRENCE:
- CAVIGLIA, O.P., SADRAS, V.O., ANDRADE, F.H., 2004. INTENSIFICATION OF AGRICULTURE IN THE SOUTH-EASTERN PAMPAS I. CAPTURE AND EFFICIENCY IN THE USE OF WATER AND RADIATION IN DOUBLE-CROPPED WHEAT-SOYBEAN. FIELD CROPS RES. 87, 117-129.