*Journal of Basic & Applied Sciences,* 2012, *8,* 379-385 

# Performance of some Promising Genotypes of Soybean Under Different Planting Dates Using Biplots Analysis

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**Abstract:** Soybean yield is affected by planting dates and there are significant efficiency losses when planting are done outward a relatively restricted period. Genotypes and environment are major contributing factor of plant phenotype. Economically important quantitative traits include agronomic characteristics. Four separate experiments are carried out in each season at the experimental farm of Sakha Research Station, Kafr El-Sheikh during 2010 and 2011seasons. Seed yield of six soybeans cultivars i.e. Giza 21, Giza 22, Giza 111, $H_2L_{12}$, $H_{30}$ and $H_{32}$ examined at four different sowing dates i.e. 20th April, 5th May, of 20th May and 5th June of their effect on seed yield, and yield components. Highest number of branches/plant, number of pods/plant, 100 seed weight (g), and seed yield. Soybean cultivars showed high difference in seed yield and its component, Giza 21 exhibited maximum number of pods/plant, 100 seed yield, and seed yield. $H_{32}$ cultivar contributed highest number of branches/plant. Through genotypes and genotypes x environment biplots of regression model analysis results, the performance of a cultivar at different environments was compared, the performance of six cultivars at different environments (planting dates) were compared. The results indicated that sown on 5th May increased seed yield/ha by 19.7% compared with sown on 5th June and increased seed yield by 17.9% compared with sown on 20th April, and increased seed yield by 10.3% compared with sown on 20th May. It could be noticed that Giza 21 cultivar exceeded H32 line by 16.63%, H30 line by 14.6%, Giza 22 cultivar by 13.7%, H2L12 line by 6.5% and Giza 111 by 5.3% in seed yield/ha. Highest yielding cultivars at the different mega environments were identified, and ideal cultivars and test planting date was identified. It could be suggested that soybean genotypes of Giza 21 and Giza 111 are the most promising for planting date 5th May and recorded concentrated seed yield/ha.

**Keywords:** Soybean genotypes, sowing dates, biplots analysis, seed yield and yield attributes.

## INTRODUCTION

Soybean is the world's leading economic oilseed crop. The area cropped to soybean in Egypt has averaged 10900 ha during the 1970's and in 1980's, average acreage has increased rapidly reaching about 49800 ha. Since this time, this area has declined to reaching about 9000 ha during the 2011 because most soybean is grown on highly fertile soil in the Nile valley, where the other summer crops i.e. rice, corn, and cotton are strong competitors probably due to their high net returns. In order to reduce the gap between oil production and its consumption which reach 10% from our production only? Recently interest has increased in the potential of growing soybean in the new reclaimed areas outside the Nile valley, where different environments of agriculture may be available. Soybean is a short-day plant that originated from latitudes of about 45$^{o}$ N. The cultivars currently available are heavily influenced by the planting period. In the research station at Kafr El-Sheikh, located between 31 ° east longitude and 31° north latitude, 6 m above the sea level. Sowing date has more effect on soybean seed yield than any other production practice. The global warming climate change started to restrict not only the expansion of the cultivated area, but also the stability of the current agricultural production, and may be different in planting date, So, this study to performance of some soybean genotypes under different planting dates in north Egypt. Planting date is perhaps the most important and least expensive cultural consideration that impacts soybean yield. Current recommendations for soybean are to sown from mid-May through June [1]; however, farmers believe that earlier planting results in greater yield [2, 3]. Other findings revealed no difference in yield, or a yield reduction when soybean was planted in early compared with late May [4].

Planting date impacts soybean growth characteristics. Early planting of indeterminate soybean cultivars result in more nodes [1] and a greater numbers of pods, higher seeds weight/plant as well as higher weight of 100 seeds weight [5-10]. These yield component changes are linked to extended vegetative and reproductive development during R1 [11] through R8 soybean growth stages in early vs. late-planted soybean. Late-planted soybean often has a higher floral abortion rate. A shorter day length can also decrease growth stage length [12] and increase seed mass. Planting early can stimulate early initiation of R5 and lengthen the duration of the R5 through R6 period [1, 13]. When planted early, R5 through R6 begins in

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ISSN: 1814-8085 / E-ISSN: 1927-5129/12 

warmer weather compared with soybean planted in late May or early June. The objectives of this study are aimed to study to demonstrate the usefulness of additive main effects and multiplicative interactions G plus GE interaction (GGE) biplots. Analysis in interpreting GE grain yield data, and study the response of soybean cultivars to different sowing dates.

## MATERIALS AND METHODS

Field experiments were carried out at the experimental farm of Sakha Research Station, Kafr El-Sheikh, during 2010 and 2011 summer seasons. The aim of this study to investigate the response of soybean (*Glycine max* (L.) Merrl) cultivars i.e. Giza 21, Giza 22, Giza 111, H2L12, H30 and H32 to different sowing dates 20$^{th}$ April, 5$^{th}$ May, of 20$^{th}$ May and 5$^{th}$ June on seed yield, yield components of soybean. The experimental design was conducted in randomized complete block design (RCBD) with four replications. Four separate experiments in each season in 20$^{th}$ April, 5$^{th}$ May, of 20$^{th}$ May and 5$^{th}$ June include of each Giza 21, Giza 22, Giza 111, H2L12, H30 and H32genotypes. Then combined analysis was done between sowing dates to obtain the main effect of planting dates and interaction between cultivars and planting dates. Each plot consisted of four ridges, 60 cm apart and four m long. Seeds of all genotypes were inoculated by specific *rhizobia* and then hand planted at density of 15 plants per a meter of a linear ridge on the sowing dates. All other agricultural practices were conducted as recommended for Sakha location.

The data of number of days to flowering, number of days to maturity, were recorded on plot basis. Ten guarded plants were randomly taken from each plot to measure plant height (cm), number of branches/plant, number of pods/plant, 100-seed weight (g) and seed weight/plant (g). Also, data of seed yield was determined from the central area (4.2 $m^2$) in each plot, then transformed to ton/fed.

### Statistical Analysis

All the data collected were subjected to statistical analysis of variance as described by [14] combined analysis of sowing dates experiments to obtain the mean effects of sowing dates and their interaction with cultivars according to [15]. The mean values were compared according to Duncan's Multiple Range Test [16].

### Genotypes and Genotypes x Environment (Biplot Analyses)

The genotypes and genotypes x environment (CGE) biplot methodology, which is composed of two concepts, the biplot concept [17] and (genotypes and genotypes x environment) concept [18] was used to visually analyze the results of SREG analysis of MET data. This methodology uses a biplot to show the two factors (G plus GE) Genotypes + genotypes x environment that are important in cultivar evaluation and that are also the sources of variation in SREG model analysis of MET data [18, 19]. The GGE biplot shows the first two principal components (PC1 and PC2, also referred to as primary and secondary effects, respectively) derived from subjecting environment-centered yield data (the yield variation due to GGE) to singular value decomposition [18]. In this study, GGE biplots were used to compare the performance of different genotypes at an environment, identify the highest yielding genotypes at the different mega environments, and identify ideal cultivars and test locations.

## RESULTS AND DISCUSSION

### A. Genotypes Performance

Soybean genotypes in all planting dates were reached the significance level of probability for seed yield and its attributes characters (Table **1**), indicating the extended of genetic diversity in the material selection for this study, or wide diversity between the parental materials used in the present study. Significant genotypes by lanting dates were detected for all the studied traits, indicating that the genotypes behaved somewhat differently from planting date to another. Significant means due to interaction between genotypes and planting dates were obtained for all the studied traits. These results therefore, might reveal the performance of genotypes differed from one planting date to another. Giza 22, Giza 111, H32 genotypes surpassed other genotypes in plant height number and pods per plant without significant differences between them in both seasons. Giza21, Giza 111, H2L12 and H32 genotypes exceeded the other cultivars in 100-seed weight and seed yield/ha without significant differences between them in both seasons. The differences between soybean cultivars might be due to the genetically factors and heredity variation among cultivars under study which caused differed in seed yield and its attributes. Over both seasons, it could be noticed that Giza 21 cultivar exceeded H32 line by

**Table 1: Means of Seed Yield and its Attributes as Affected by Genotypes and Planting Dates During 2010 and 2011 Seasons**

| Treatments | Plant height | | Number of branches | | Number of pods | | 100 –Seed weight (g) | | Seed Yield (t/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| **A. Sowing dates:** | | | | | | | | | | |
| 20th April | 82.52c | 76.11d | 3.39b | 3.92a | 79.64c | 84.28b | 15.87b | 16.19c | 4143.58c | 4386.34c |
| 5th May | 98.08b | 93.50b | 3.90a | 4.20a | 92.36a | 98.39a | 17.27a | 17.92a | 5059.88a | 5331.20a |
| 20th May | 104.56a | 105.33a | 3.09c | 3.13c | 87.01b | 96.17a | 17.05a | 16.47b | 4526.76b | 4793.32b |
| 5th June | 74.65d | 87.67c | 3.15c | 3.42b | 72.20d | 76.90c | 14.03c | 14.69d | 4107.88c | 4236.40c |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| LSD 5% | 2.25 | 3.26 | 0.19 | 0.28 | 2.72 | 4.80 | 0.26 | 0.20 | 184.21 | 271.58 |
| **B. Soybean Cultivars:** | | | | | | | | | | |
| Giza 21 | 95.19a | 96.08a | 3.26b | 3.38d | 86.11a | 88.57a | 17.28a | 17.28a | 4936.12a | 5164.60a |
| Giza 22 | 86.23cd | 84.00c | 3.38b | 3.50bcd | 75.90c | 80.12b | 15.92c | 15.88c | 4248.30c | 4464.88cd |
| Giza 111 | 92.45ab | 95.25a | 3.23b | 3.82ab | 86.27a | 93.53a | 16.46b | 16.29b | 4717.16ab | 4845.68ab |
| H2L 12 | 88.52c | 88.83b | 3.46b | 3.75bc | 85.07a | 93.18a | 15.42d | 16.22b | 4674.32b | 4786.18bc |
| H 30 | 84.87d | 86.00bc | 3.26b | 3.43cd | 79.5b | 87.65a | 15.66cd | 16.12b | 4079.32c | 4545.8bcd |
| H 32 | 92.38b | 93.75a | 3.70a | 4.13a | 83.89a | 90.55a | 15.60cd | 16.10bc | 4105.50c | 4314.94d |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| LSD 5% | 2.75 | 3.99 | 0.23 | 0.35 | 3.33 | 5.88 | 0.32 | 0.25 | 225.86 | 332.72 |
| F. Test AXB | ** | ** | ns | ns | ** | ** | ** | ** | ** | ** |

*, ** and NS indicate P< 0.05, P < 0.01 significant and not significant, respectively. Means designated by the same letter within columns are not significantly different at the 5% level according to Duncan's multiple range tests.

16.63%, H30 line by 14.6%, Giza 22 cultivar by 13.7%, H2L12 line by 6.5% and Giza 111 by 5.3% in seed yield/ha. These results in good accordance with those reported by [6-8, 10, 20].

## B. Planting Dates Effects

Results presented in Table **1** showed that significant effect on seed yield and its attributes due to planting dates under this study were observed, in early planting date on 20th May being highest among those in other planting dates at plant height for all the studied traits and planting on 5th May for other yield and yield component. The increase in these traits at early planting date may be due to the prevailing of favorable temperature and day length leading to greater of these attributes of soybean plants. Maximum seed yield/ha was produced from sowing on 5th May followed by sown on 20th May which could be due to highest yield attributes such as number of branches/plant, number of pods/plant and seed index as showed in Table **1** compared with other sowing date. A greater numbers of pods, higher seeds weight/plant as well as higher weight of 100 seeds weight [5-10]. These results are in harmony with those obtained by [3, 7, 13]. Over both seasons, the results clearly indicated that sown on 5th May increased seed yield by 19.7% compared with sown on 5th June and increased seed yield by 17.9% compared with sown on 20th April, and increased seed yield by 10.3% compared with sown on 20th May.

## C. Interaction Effects

The interactions of planting dates with soybeans genotypes were significant for all studied traits. These significant interactions with planting dates are mainly attributed to the different ranking of soybean genotypes from planting dates to another, revealing that the studied behaved somewhat differently from planting dates to another. Results in Table **2** showed that plant height significantly influenced by the interaction between planting dates and soybean genotypes. The differences between plant height for the third planting date 20th May and the shortest plant for the fourth planting dates reached about 50 cm and 40 cm in both seasons, respectively. The tallest soybean genotype was Giza 21which planting date at 20th May. Moreover, highest number of pods per plant reached the highest

**Table 2: Means of Seed Yield and its Component as Affected by the Interaction Between Soybean Genotypes and Planting Dates in 2010 and 2011 Seasons**

| Genotypes | Plant height | | Number of pods /plant | | 100 –Seed weigh (g) | | Seed yield (kg/he.) | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| **20th April** | | | | | | | | |
| Giza 21 | 82.59 l | 72.33i-m | 81.35def | 81.67fg | 17.57bc | 17.57b | 4569.6b-g | 4988.48c-f |
| Giza 22 | 85.73j | 76.00j-m | 61.60h | 63.40h | 15.04hij | 14.48e | 4224.5fgh | 4560.08d-h |
| Giza 111 | 74.68n | 69.67m | 76.37efg | 85.07d-g | 16.45ef | 16.55c | 3719.94ij | 3974.6h-j |
| H2L 12 | 82.95 l | 79.00i-l | 74.09g | 81.87fg | 14.59ijk | 15.62d | 4914.7bc | 5074.16cde |
| H 30 | 82.59 l | 74.67j-m | 91.35bc | 94.80b-e | 16.43ef | 17.42b | 4115.02hi | 4626.72d-h |
| H 32 | 86.58j | 85.00ghi | 93.12ab | 98.87abc | 15.13hi | 15.47d | 3101.14k | 3101.14k |
| **5th May** | | | | | | | | |
| Giza 21 | 100.50de | 99.33bcd | 99.36a | 106.87 a | 18.87a | 18.69a | 6233.22a | 6192.76a |
| Giza 22 | 91.67i | 82.00g-j | 94.38ab | 94.27cde | 17.26cd | 17.35b | 4974.2b | 5193.16cd |
| Giza 111 | 96.50h | 98.00cd | 98.21a | 106.40ab | 17.95b | 18.49a | 5921.44a | 5859.56ab |
| H2L 12 | 99.50f | 99.00cd | 94.06ab | 101.80abc | 15.91fg | 18.32a | 4809.98b-d | 4581.5d-h |
| H 30 | 101.00d | 93.33def | 93.00abc | 97.73abc | 16.94de | 17.34b | 4307.8e-h | 5428.78bc |
| H 32 | 99.00f | 89.33efg | 75.11fg | 83.27d-g | 15.67gh | 17.35b | 4119.78g-i | 4733.82d-g |
| **20th May** | | | | | | | | |
| Giza 21 | 114.00a | 116.33a | 91.18bc | 90.47c-f | 18.64a | 17.49b | 4531.52b-h | 4664.8d-g |
| Giza 22 | 104.33c | 104.67bc | 74.04g | 79.73fg | 16.91de | 16.20c | 4386.34d-h | 4650.52d-g |
| Giza 111 | 110.50b | 116.33a | 91.22bc | 108.40a | 17.65bc | 16.68c | 4790.94b-d | 5414.5bc |
| H2L 12 | 101.00d | 99.33bcd | 96.82ab | 109.40a | 16.50ef | 16.46c | 4650.52b-f | 4969.44c-f |
| H 30 | 97.83g | 95.67de | 82.39de | 94.07cde | 15.93fg | 16.41c | 4291.14e-h | 4400.62fgh |
| H 32 | 99.67ef | 99.67bcd | 86.43cd | 94.93bcd | 17.72bc | 15.55d | 4512.48c-h | 4664.8d-g |
| **5th June** | | | | | | | | |
| Giza 21 | 75.91m | 87.00fgh | 73.71g | 75.73g | 14.06klm | 15.56d | 4719.54b-e | 4814.74c-f |
| Giza 22 | 63.18p | 73.33klm | 73.60g | 83.07efg | 14.46jkl | 15.48d | 3408.16jk | 3458.14jk |
| Giza 111 | 70.45o | 80.67h-k | 78.14efg | 78.87fg | 13.78mn | 14.32e | 4124.54g-i | 4138.82ghi |
| H2L 12 | 70.61o | 78.00i-l | 75.29fg | 83.73d-g | 14.67ijk | 14.77e | 4317.32e-h | 4517.24e-h |
| H 30 | 83.18 l | 100.00bcd | 51.58i | 54.87h | 13.32n | 13.32f | 3603.32j | 3722.32i-k |
| H 32 | 84.55k | 107.00b | 80.89def | 85.13d-g | 13.89lmn | 14.67e | 4693.36b-e | 4764.76c-g |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** |
| LSD 5% | 1.2 | 7.99 | 6.66 | 11.77 | 0.64 | 0.49 | 451.48 | 665.45 |

*, ** and NS indicate P< 0.05, P < 0.01 significant and not significant, respectively. Means designated by the same letter within columns are not significantly different at the 5% level according to Duncan's multiple range tests.

value with the soybean genotypes Giza 111 and $H_2L1_2$ with the third planting date on 20th May in both seasons. Regarding 100 seed weight and seed yield/ha results clearly showed that highest 100 seed weight and seed yield /fed were obtained from the second planting date on 5th May, with the soybean cultivar Giza 21, On the other hand, the soybean line $H_{30}$ showed minimum values in fourth planting date for 100 seed weight, in both seasons. Seed yield showed the soybean cultivar Giza 22 the lowest in fourth planting date in both seasons. Planting early can stimulate early initiation of R5 and lengthen the duration of the R5 through R6 period [1, 13]. When planted early, R5 through R6 begins in warmer weather compared with soybean planted in late May or early June. Similar conclusions were reported by [21].

### D. Performance of Different Genotypes at a Specific Environment

The genotypes and genotypes x environment (GGE) biplot of the SREG analysis results were used to show the relative performance of all cultivars at a specific environment. The two planting dates 5th May and 20th May are positively correlated because the angle between their vectors is <90°, in the same time. The two planting dates 20th April and 5th June are negative correlated, in both seasons, respectively. Similar genotypes are positioned closely; genotypes that are similar in genotypes x environment (GE) directions have a small angle (Giza 21 and Giza 111 in Figure **1**) while dissimilar genotypes have a large angle (the angle formed between the first genotype, the origin and the second genotype) H2 L12 and H30 in Figure **1** in both seasons, respectively.

Genotypes far from the origin (Giza 21 and H30 in Figure **1**) have a large genotype plus interaction effect. If a given genotype and a given location vector are on the same side of the origin (Giza 21 and second planting date5th May) that genotype performs above

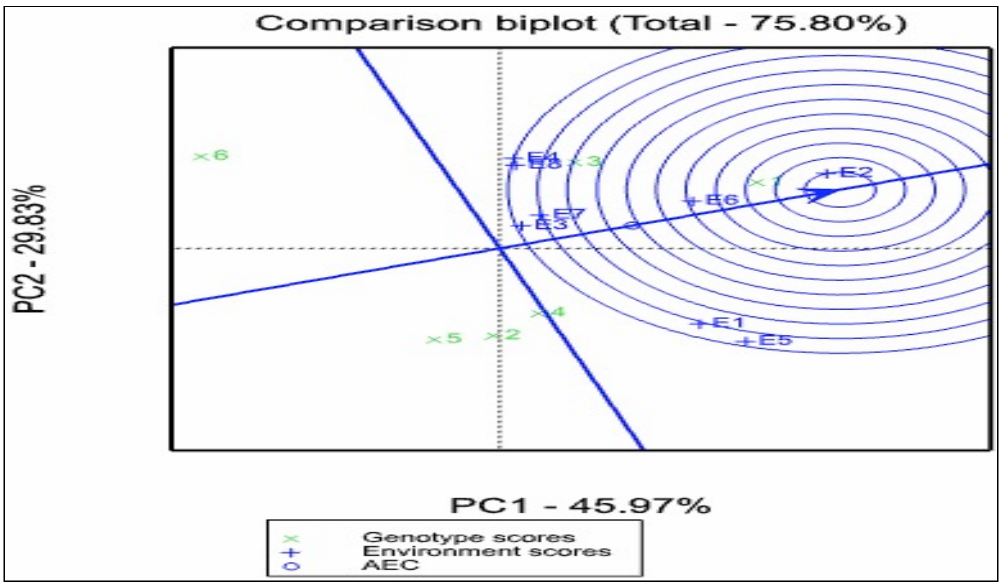


**Figure 1:** Genotype plus genotype x environment (GGE) biplot obtained from sites regression (SREG) analysis showing the performance of different genotypes at different environment (planting dates).

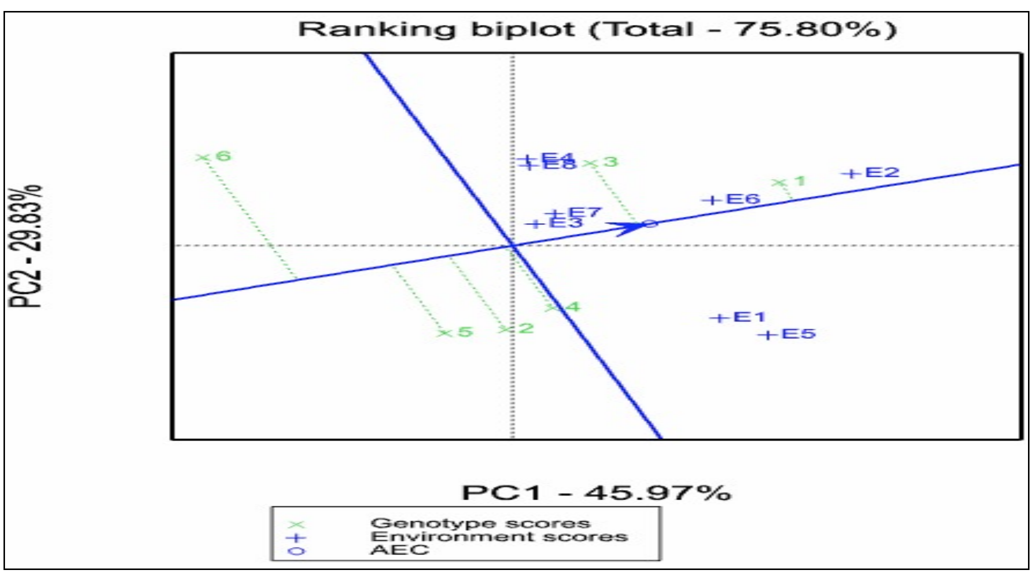


**Figure 2:** Genotype plus genotype x environment (GGE) biplot obtained from sites regression (SREG) analysis showing the performance of different genotypes at different environment (planting dates). The average planting date coordination for entry evaluation.

average in that location. By contrast, a genotype which is at the opposite side of a location vector origin (H30 and first planting date 20th April) performs below average in that environment. Genotypes close to the origin have average performance in all environments [18].

The average performance and stability of the entries can be visualized using "Biplot Tools" and then "Means vs. Stability". The graph that will appear is shown in Figure **2**. The most important features of the graph are a small circle indicating the position of the average location, which is defined by the average PC1 and PC2 scores across all locations. This average location can be regarded as a virtual location; a thick line that passes through the biplot origin and the average location, referred to as the Average-Tester Axis (ATA) or Average Tester Coordination (ATC) Abscissa; The arrow pointing to the average location from the biplot origin; a thick line that passes through the biplot origin and is perpendicular to the ATA; a set of lines parallel to the thick lines, which start from the marker of the entries and project to the ATA.

## CONCULOSIONS

For exploiting seed yield could be suggested by sowing Giza21, Giza 111, H2L12 and H32 genotypes on 5th May or 20th May. The genotypes and genotypes x environment (GGE) biplot of the SREG analysis showed that genotypes are positioned closely; genotypes that are similar in genotypes x environment (GE) directions have a small angle (Giza 21 and Giza 111). Genotypes far from the origin (Giza 21 and H30) have a large genotype plus interaction effect. Highest yielding cultivars at the different mega environments were identified, and ideal cultivars and test planting date was identified.

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Received on 05-06-2012 Accepted on 01-07-2012 Published on 26-07-2012

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